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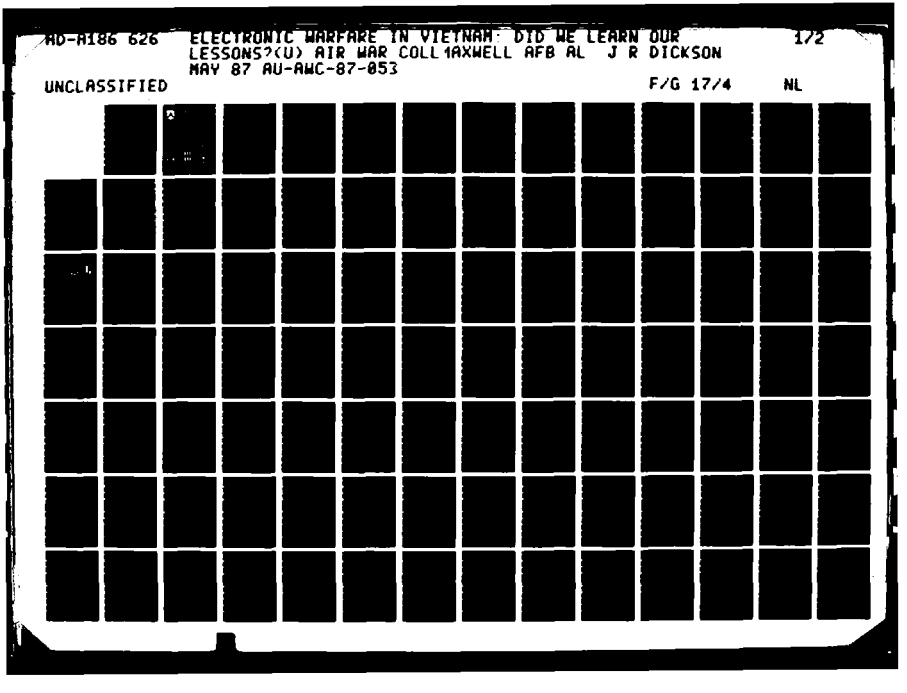

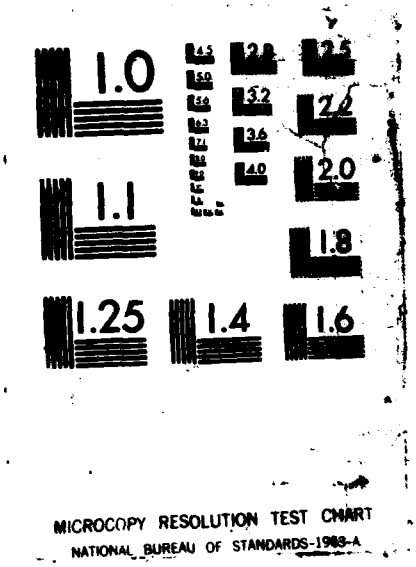
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# AIR WAR COLLEGE

# RESEARCH REPORT



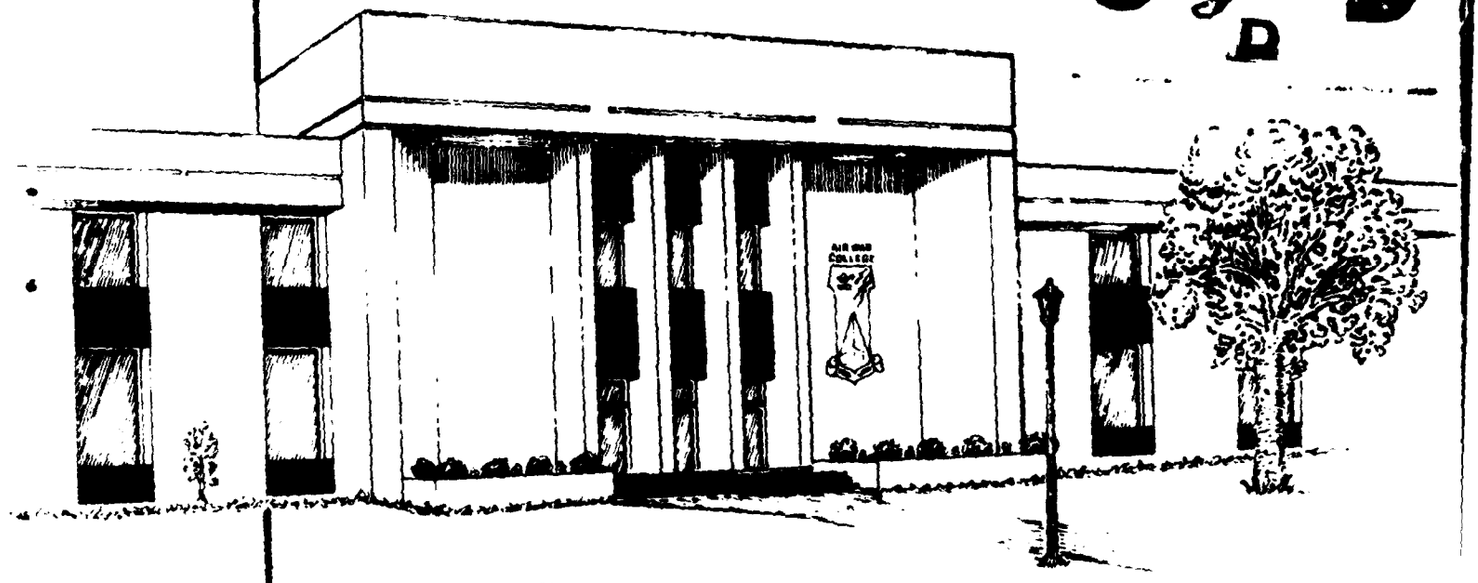
No. AU-AWC-87-053



## ELECTRONIC WARFARE IN VIETNAM: DID WE LEARN OUR LESSONS?

By COLONEL JOHN R. DICKSON, USA





AIR UNIVERSITY
UNITED STATES AIR FORCE
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AIR WAR COLLEGE
AIR UNIVERSITY

# ELECTRONIC WARFARE IN VIETNAM:

# DID WE LEARN OUR LESSONS?

by

John R. Dickson
Colonel, USA

A RESEARCH REPORT SUBMITTED TO THE FACULTY

IN

FULLFILLMENT OF THE RESEARCH

REQUIREMENT

Thesis Advisor: Doctor Howard M.Hensel
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MAXWELL AIR FORCE BASE, ALABAMA

May 1987

DISCLAIMER-ABSTAINER

This research report represents the views of the author and does not necessarily reflect the official opinion of the Air War College or the Department of the Air Force.

AIR WAR COLLEGE RESEARCH REPORT ABSTRACT

TITLE: Electronic Warfare in Vietnam: Did We Learn Our Lessons?

AUTHOR: John R. Dickson, Colonel, USA

The air war over North Vietnam is reviewed with emphasis on the electronic warfare (EW) aspects of the air campaign. The North Vietnamese air defense system is described along with the electronic countermeasures (ECM) used by American aircrews to neutralize these weapons. An analysis of the EW operations reveals that the U.S. did not provide adequate electronic protection for its aircraft, did not have adequate EW doctrine and tactics, and did not train their commanders, staff officers and aircrews to use EW as a combat multiplier. To determine whether these deficiencies have been corrected, the opinions and perceptions of 33 former commanders and operations officers of flying units were surveyed. The results of this survey reveal that the U.S. has not provided complete ECM protection for its combat aircraft. Most flying units have an extensive set of EW tactics, which they practice often. Crews are adequately trained in the principles of EW but most commanders feel they need a realistic threat simulator for routine training and evaluation of tactics.

## BIOGRAPHICAL SKETCH

Colonel John R. Dickson (B.S. Meteorology, Texas A & M University; M.S. Geology, University of New Mexico) has held various positions as an intelligence and electronic warfare officer in tactical, strategic and joint assignments throughout the world, including duty in West Germany, Berlin, Korea, and Great Britain. In 1968, he served in the Republic of Vietnam with the 2d Battalion, 28th Infantry, 1st Infantry Division, and with the 1st Military Intelligence Battalion (Aerial Reconnaissance Support). From 1973 to 1976, he was Assistant Professor of Earth and Space Sciences, United States Military Academy, West Point. Prior to selection for the war college, Colonel Dickson was Deputy Assistant Chief of Staff, G2, Headquarters, VII Corps. He is a graduate of the U. S. Army Command and General Staff College and the British Staff College. Colonel Dickson is a graduate of the Air War College, Class of 1987

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# CHAPTER I

## INTRODUCTION

The air war in Southeast Asia (SEA) presented the first opportunity for American forces to conduct modern electronic combat (EC). Although the enemy in Vietnam did not present a credible electronic threat to our ground and naval forces, the North Vietnamese air defense forces used radars, guided missiles and radar-assisted, ground-controlled interceptors to attack and frustrate our fighters and bombers operating north of the Demilitarized Zone (DMZ). Not prepared for this electronic threat, our Air Force, Navy and Marine pilots soon found themselves in the fast-moving, deadly environment that electronic weapons bring to war. Though relatively unsophisticated, the electronic systems used by North Vietnam took their toll. The U.S. Air Force, after a thorough analysis of the Vietnam experience, Concluded that:

> The North Vietnam defense system (antiaircraft guns, surface-to-air missiles, and high performance interceptors- all radar supported) was never suppressed to the degree necessary for complete freedom of operation. (1:37)

Only the best technical ingenuity and battlefield innovation allowed our fliers to accomplish their mission without crippling losses.

Future wars will present a more sophisticated electronic threat and will not permit our aircrews an

opportunity after hostilities begin to develope equipment and tactics to meet the threat. Our electronic warfare (EW) capability must be ready from the start.

The valuable EW lessons learned in the air over North Vietnam have never been consolidated and analyzed in their full historical context. Most of these lessons were reported in various classified and unclassified after-action reports and personal accounts of the war. The Air University CORONA HARVEST reporting series contains many of these lessons. Because some of these reports were recently declassified, we now have an excellent opportunity to produce an unclassified analysis of our EW experience in Vietnam that can receive widest distribution to the leaders and planners of all four services.

## Purpose

The purpose of this research is to determine whether the U.S. armed forces have corrected the EW deficiencies identified in the Vietnam War. The research will attempt to answer the following questions:

a. What electronic warfare lessons were learned in Vietnam? What key deficiencies in EW equipment, tactics and doctrine were identified?

b. What has been done by the services to correct these deficiencies?

c. What still needs to be done to ensure that the U.S. can conduct effective EW in any future conflict?

## Methodology

A search of historical documents and publications available at the Air War College and at the Headquarters, USAF Electronic Security Command (ESC), the Air Force Electronic Warfare Center (AFEWC), and the Joint Electronic Warfare Center (JEWC) was performed to document the EW lessons reported from SEA. Telephonic inquiries to military historical offices in the Washington, D.C., area were made to ensure that historical lessons from all sources were included in the study.

To determine if EW deficiencies have been corrected, a survey was performed to identify perceptions and opinions of thirty-three senior officers at the Air War College on the current status of our EW capability. Sampled officers all had operational experience in the last four years, serving as commanders or operations officers of Army, Navy, Marine Corps and Air Force flying units. They included tactical fighter and reconaissance squadrons, strategic bomber squadrons and attack helicopter units. A sample of the questionaire used in the survey is at APPENDIX A. Objective responses were compiled and compared to determine whether a clear consensus existed on any of the issues. Respondent's comments were also compiled to explain their objective response, identify any subjective consensus that may exist, and identify ideas for future EW development. Some respondents were personally interviewed to clarify and amplify their response and to

discuss classified aspects of their response.

This study is not a detailed, technical analysis of the electronic war in Vietnam or our EW capability today. Instead, it is an analysis of history and opinions to be used by the non-technical readers - the leaders, senior planners and pilots who need to know the lessons of history and the perceptions of some of our flying leaders today. To accomplish this, many classified references were deliberately omitted from the study. Most of these classified documents discuss specific technical aspects of EW that would add little to the content of the study and limit its distribution and use.

## CHAPTER II

## AIR OPERATIONS AND AIR DEFENSE IN SOUTHEAST ASIA

To understand how the air war in SEA has impacted on the development of EW capabilities in the past decade, it is necessary to review the air campaign over North Vietnam, the air defense threat presented by the North Vietnamese, and the EW tactics and hardware used by the U.S. pilots to counter that threat. It is not within the scope of this study to provide an extensive and detailed history of the air war in North Vietnam. Instead, the major aspects of the war that created the EW lessons of SEA will be presented. For a more extensive study of the air campaign over North Vietnam, the reader is referred to numerous personal and official histories of the war. General Momyer's synopsis of the air war in Southeast Asia is an excellent source.(2) The CORONA HARVEST reports on file with the Albert F. Simpson Historical Research Center provide specific, technical details of all aspects of the air operation and summaries of numerous of personal experiences in SEA.

### The Air Campaign

The American air war over North Vietnam lasted over seven years but can hardly be described as a continuous and concentrated bombing campaign to bring the North Vietnamese to their knees. Instead, the air war evolved into a series of short, intensive campaigns, lasting less than a few days

to several months and each carefully contrived to accomplish important military and political goals while avoiding equally important political hazards perceived by the American leadership.

Taken in total, the U. S. air effort was impressive. From the first raids in August, 1964, until the release of our prisoners of war in 1973, the United States flew over 300,000 sorties and dropped over 900,000 tons of ordnance on North Vietnam. (3:267-283; 4:99) Compared with the 2 million tons of air ordnance dropped by our aircraft in Korea, the American effort against North Vietnam appears to be substantial, considering the small size of North Vietnam and the unconventional nature of the ground war. American losses depict a major and costly effort. More than 900 US aircraft were destroyed by North Vietnamese gunners, missiles and interceptors. (3:9,283) Nearly 300 American airmen were lost and another 500 captured after ejecting over enemy territory. *

ROLLING THUNDER: 1965-1968

The air war over North Vietnam consisted of at least 62 different operations, each with its own specific mission and operational restrictions. In the early campaigns, the

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* The general figures cited here are from the Cornell University study on bombing effectiveness, supplemented with official U.S. Air Force estimates for later air campaigns. (3:267-284; 4:167; 4:171)

restrictions were progressively relaxed to create what President Johnson called a "slowly ascending tempo" of military action.(6:4) In several instances, the air operations were stopped completely in recognition of holiday periods or to encourage the North Vietnamese to resume peace negotiations. These bombing halts, while lasting no more than a month, gave the North Vietnamese much needed opportunities to rebuild, resupply and improve their air defense system. Each time our fliers returned, they found the opposition more formidible. (3:39-43; 4:98-99)

The severe constraints placed on our pilots attacking North Vietnam made them extremely vulnerable to the North Vietnamese defenses and magnified the importance of protective ECM and deception. The early ROLLING THUNDER attacks were carefully controlled from Washington, often preventing the attackers from operating in large portions of North Vietnam. Initially, raids were restricted to targets south of the 18th or 20th parallel. Later, when the air war went further north, a 30-mile radius around Hanoi and a 10-mile circle around Haiphong, along with a 30-mile buffer along the Chinese border, were observed. The North Vietnamese were quick to recognize these "safe areas" and place their surface-to-air missiles (SAM) and ground-controlled-intercept (GCI) centers within them. (7:151)

The strong imperative to avoid collateral damage demanded attacks against small, "point-type" targets such as

barracks, bridges and supply depots. Such small targets forced the attackers to expose themselves longer to enemy defenses to ensure that the targets were destroyed. These restrictions, along with centralized control, the "gradualism" of the U.S. strategy, and the restrictive terrain and weather in North Vietnam, gave the the Vietnamese a distinct defensive advantage. U.S. airmen found themselves repeatedly attacking the same targets using tactics that were stereotyped and easily exploited by the enemy. (7:151-152)

On 1 November, 1968, President Johnson stopped all bombing of North Vietnam in an effort to induce the North Vietnamese to seriously pursue a peaceful settlement of the conflict. The next four years were relatively quiet in the north, interrupted only by "protective reaction" strikes by the U.S. In February and May of 1970, particularly large strikes were flown against SAM sites, anti-aircraft artillery (AAA) positions and military logistics facilities in the north. During this lull, the North Vietnamese added to its MIG-21 inventory and improved its air defense units and procedures. (4:89,92)

LINEBACKER I and II: 1972

On 8 May, 1972, President Nixon responded to a North Vietnamese ground offensive in the south by resuming full-scale bombing attacks against key targets around Hanoi and Haiphong, supplemented by a naval blockade and mining of Haiphong and other ports. When negotiations with the North

Vietnamese showed some promise, President Nixon halted all attacks north of the 20th parallel. However, after several weeks of diplomatic frustration, on 18 December the president ordered the initiation of an intensive, 11-day bombing campaign that, for the first time, included massive night bombing around Hanoi and Haiphong by B-52's. This campaign, that was to be the last of the war, involved almost every available aircraft in the U.S. inventory. (4:95-99) Using laser-guided bombs and radar bombing techniques, the continuous pressure destroyed a major part of North Vietnam's industrial and transportation capability and virtually destroyed their extensive air defense system. (23:239-240) When the North Vietnamese agreed to negotiate, the U. S. restricted bombing to targets below the 20 parallel. They ceased all offensive operations against North Vietnam on 15 January 1973. (4:99)

## North Vietnamese Air Defense System

The North Vietnamese air defense system that American airmen faced between 1965 and 1972 has been described by various authors as "imposing" and "one of the most formidible air defense systems ever developed." (7:205; 4:74) Others have given these defenses the ultimate technical compliment calling it a "fully integrated" system. (8:236) To the credit of those flyers who daily braved the North Vietnamese flak, missiles and interceptors, the air defense system they saw was indeed impressive. However, a

detailed and objective analysis of the defenses through the war years suggests that, while it was vast and well-coordinated, it was far from modern and sophisticated, even in the context of the 1960s and '70s.

When the bombing began, the North Vietnamese defenses consisted of what one Air Force historian called an "unorganized array of radars and approximately 1,000 AAA guns." (9:56) Within a year, the North Vietnamese doubled their AAA force, acquired more radar-controlled guns, developed a country-wide GCI system with various surveillance radars, and fielded a significant number of the radar-guided SA-2 missiles. (4:74)

Anti Aircraft Artlillery (AAA)

A vast array of AAA and automatic weapons (AW) formed the foundation of the North Vietnamese air defense system. Ranging from radar-controlled 100mm guns to the shoulder-fired AK-47, these weapons formed a protective blanket that covered almost the entire country and posed the most serious threat to U.S. aircraft over North Vietnam. By 1968 there were about 6000 dedicated AAA weapons of all caliber in North Vietnam. Half of these were concentrated in the area around Hanoi and Haiphong, and to the northwest of Hanoi. At the peak of our air operations, the larger radar-controlled AAA weapons were fully coordinated with SAMs and interceptors to improve their effectiveness. (9:56) Although American efforts to reduce the SAM and interceptor

threat were showing significant returns by early 1968, the AAA threat continued to grow and improve so that it could claim credit for 80% of all friendly aircraft downed by then. (9:6) This performance is particularly impressive when one notes that all these AAA weapons used technology that emerged during or just after World War II. The 57mm gun, S-60, was introduced into the Soviet Inventory in 1950. The FIRECAN radar that guided the 57mm, 85mm and 100mm gun batteries was a Soviet copy of a radar built by Westinghouse in the 1940's using very unsophisticated electronic concepts and components. (10:471) Statistics to demonstrate the relative effectiveness of this radar-controlled AAA are hard to find. One study reported that radar-controlled AAA guns accounted for 14% of all aircraft losses in the last three months of 1967. (9:75)

The Soviet Union introduced the deadly ZSU 23-4 to their inventory in 1965. Had the North Vietnamese acquired this sytem, with its high rate of fire and relatively modern GUN DISH radar, before the war in SEA ended, our pilots would have faced a greater AAA challenge. (11:5.93)

Surface-to-Air Missiles(SAM)

The North Vietnamese SAM capability received extensive and perhaps undeserved attention by those who watched the air war in Southeast Asia. Through the war years, SAMS accounted for less than 10% of all U.S. aircraft losses. But, because we were not prepared to fight against

this weapon system, the SAM "became a major factor in shaping tactics and equipment requirements" for the USAF. (9:25)

The mainstay of the North Vietnamese SAM force, the Soviet-made SA-2 GUIDELINE, was first introduced into their defenses around Hanoi in early 1965. On 23 July 1965, an American F-4C was the first U.S. aircraft to fall victim to the SA-2. By early 1966, the North Vietnamese had at least 56 SAM sites and were working hard to integrate these radar controlled missiles into their array of AAA guns and fighter-interceptors. (4:74) By 1967 there were about 200 SAM sites in North Vietnam, each with 4 to 6 launchers. The heaviest concentrations were around Hanoi, where in 1972 there were as many as 100 missile-ready launchers to meet the Christmas offensive that year. (2:123-124) More than 1,000 SA-2s were launched during that 11-day campaign, depleting the North Vietnamese supply of missiles. (4:167)

The SA-2 and its associated radars were far from state-of-the-art for 1968. Introduced into the Soviet Army in 1959, the SA-2 was already being replaced in the Soviet Army by more sophisticated SAM systems with greater range, altitude and tactical mobility along with advanced guidance systems and electronic counter-counter measures(ECCM). Table 1 shows the seven Soviet SAM systems that were fully operational in the Soviet air defense system and had been, in some cases, provided to client states by 1972 when the last

TABLE 1

SOVIET SAM SYSTEMS

OPERATIONAL BEFORE 1972

| System | Year Introduced | Guidance | Range (Km) | Max Alt (ft) | Mobility |
|---|---|---|---|---|---|
| SA-2 | 1959 | Radar Command | 35-50 | 28K | Semi-Trailer |
| SA-3 | 1961 | Radar Command(1) | 25 | 25K | Fixed |
| SA-4 | 1967 | Radar Command(2) | 80-100 | 25K | Track Mounted |
| SA-5 | 1967 | Radar Command(2) | 300 | 29K | Track Mounted |
| SA-6 | 1970 | Radar semi active | 24 | 12K | Track Mounted |
| SA-7 | 1969 | IR Passive Homing | 3.6 | 3.5K | Shoulder Fired |
| SA-9 | 1968 | IR Passive Homing | 6 | 5K | Amphib Scout Car |

(1) Possible IR terminal homing.

(2) Possible terminal homing.

Table compiled from Jane's Weapons Systems(10:97-101) and U.S. Army FM 100-2-3 (11:5.93-5.103).

U.S. air strikes were flown in Southeast Asia. (11:5.95)

In April, 1972, the enemy introduced the only modern, ground-based air defense weapon, the SA-7 GRAIL, that American fliers would see in Southeast Asia. (8:141-142) This shoulder-fired, infrared-homing missile had appeared in the Soviet inventory only three years earlier and for the remainder of the war it was a valid threat to any low-flying aircraft. Because it was a portable weapon that passively homed on an aircraft's hot engines, it was virtually impossible to detect until it was launched. The North Vietnamese used this weapon to great advantage below the DMZ against slow-moving helicopters, forward air control aircraft, and the "trail-busting" AC-130 gunships. The SA-7 played a major role during the Communist Spring offensive of 1972, especially in the battle of An Loc. (12:231,242-243) While the SA-7 may have been deployed as a short range supplement to their SA-2 and AAA coverage, there is no indication that the North Vietnamese ever fired this missile at U.S. aircraft over North Vietnam.

The U.S. was fortunate that the North Vietnamese did not receive other modern SAM systems from the Soviets. Had they acquired the SA-4 or SA-5, with their great range and improved tracking, the SA-6 with its mobility and improved guidance system, or the SA-9 with its passive infrared tracking and excellent mobility, the North Vietnamese could have presented a much greater air defense

threat to our strike aircraft. Clearly, the SAM kill-rate would have been greater.

Air Defense Radars.

The radars associated with the North Vietnamese air defense system were equally outdated and unsophisticated. Table 2 shows the radars known to be in the North Vietnamese inventory by 1972. To compensate for their lack of quality, the North Vietnamese deployed many radars in overlapping coverage. Their early warning and GCI radars formed a comprehensive network that could detect the approach of aircraft over all of western and southwestern Laos and the Gulf of Tonkin. (2:321) The North Vietnamese radars suffered from their inability to counter jamming and electronic deception. Yet, the broad diversity of these radars, with operating frequencies that extended from 70mhz to 3200mhz, presented a complicated electronic countermeasures (ECM) target that troubled U.S. forces in the early stages of the air war. (9:66)

Air Defense Interceptors

Air-to-air combat over Vietnam never matched the intensity or magnitude our pilots experienced 15 years earlier in Korea. Our Saberjet pilots in Korea learned quickly that the North Korean and Chinese MIGs could be expected to attack in formations as large as 30 to 40 aircraft. The resulting encounters became classic

TABLE 2

NORTH VIETNAMESE AIR DEFENSE RADARS

| System | Frequency Band | Approx. Range(km) | First Seen In USSR | Purpose |
|---|---|---|---|---|
| **EARLY WARNING/GROUND-CONTROLLED-INTERCEPT** | | | | |
| BARLOCK | E/F | 300 | mid 60's | Surveillance |
| KNIFE REST A | A | 90 | early 60's | Surveillance |
| KNIFE REST B/C | A | 90 | early 60's | Surveillance |
| SIDE NET | E/F | 180 | early 60's | Height Finder |
| SPOON REST A | A | 275 | late 50's | Surveillance |
| **AAA FIRE CONTROL** | | | | |
| FIRECAN | E | 80(1)<br>35(2) | early 50's | Associated w/ 57mm, 85mm and 100mm Guns. |
| WHIFF | E/F | 80<br>35 | 1950's | Same as Above. |
| **SAM FIRE CONTROL** | | | | |
| FANSONG B | E/F | 60-120 | late 50's | Detection and guidance for SA-2. |
| FANSONG E | G | 70-145 | (3) | Same as Above |
| FANSONG F | G | 70-145 | (3) | Same as above. Possible optical tracker. |

(1) Acquisition Range.
(2) Tracking Range.
(3) Data classified.

Table compiled from Jane's Weapons Systems(10:469-476) and U.S. Army FM 100-2-3 (11:5.104).

dogfights that demanded the best performance by both pilot and aircraft to survive. (2:141)

Though their presence was more than a nuisance, the North Vietnamese intercepters never were capable of a serious challenge to American air superiority. From the first air-to-air engagement, when several MIG-17's attacked a Navy strike force near Thanh Hoa on 3 April 1965, the North Vietnamese always operated in small formations under strict GCI control. Though the North Vietnamese fleet of fighter aircraft was small and relatively old, it took full advantage of the fact that the Americans would not pursue into China and often would not attack airfields in North Vietnam. (13:46; 1:3-8)

Table 3 compares the performance of North Vietnamese aircraft and selected U.S. fighter/bombers they faced. Except for the MIG-21's, the North Vietnamese inventory was no match for their American adversary. MIG-15/17's were too slow to be a significant factor, though they were useful at low altitude where their guns and agility were an advantage. The MIG-19's, which appeared after the bombing halt in 1968, had improved armament and speed, but were no match in a dogfight. The IL-28, a subsonic and obsolete bomber, never played a role in the air war. (2:138-139)

Only the MIG-21 compared favorably with its American foes. Its ability to accelerate and maneuver at various

TABLE 3

COMPARISON OF NORTH VIETNAMESE AND U.S. AIRCRAFT

| Aircraft | Max Speed Hi Alt (Knots) | Max Speed Sea Level (Knots) | Combat Radius (NM) | Year (1) | Armament |
|---|---|---|---|---|---|
| **NORTH VIETNAMESE FIGHTERS** | | | | | |
| MIG 15/17 | 618 | 578 | 378 | 1952 | 2-23mm cannon<br>1-37mm cannon |
| MIG-19 | 784 | N/A | 462 | 1955 | 3-30mm cannon<br>2-ATOLL AAM |
| MIG-21 | 1203 | 593 | 220 | 1958 | 2-23mm cannon<br>2-ATOLL AAM<br>(2) (3) |
| **U.S. AIRCRAFT** | | | | | |
| F-105D | 1390 | 855 | 900 | 1961 | 1-20mm gun |
| F-4E | 1500 | 1464 | 367 | 1967 | 1-20mm gun<br>4-AIM-7E AAM |
| A-6E | 1006 | 684 | 540 | 1970 | No Air to Air weapons. |
| A-7E | 904 | 698 | 700 | 1970 | 1-20mm gun |

(1) Year introduced into Soviet inventory.
(2) After May, 1972: 1-23mm Cannon and 4-ATOLL AAM.
(3) May have had SPIN SCAN-A search/track radar.

Table compiled from multiple sources (14,15,16,17,18).

altitudes and air speeds made it the aircraft our pilots feared most. (2:138-139) North Vietnamese pilots enjoyed the advantage that a dedicated intercepter aircraft brings. Because their mission was air defense of North Vietnam, the MIG's could patrol "clean" of any external ordnance or fuel tanks. But, because the U.S. aircraft usually were armed for bombing missions and needed heavy external fuel tanks to reach their targets, they were vulnerable if caught by surprise and could be rendered ineffective as bombers when they jettisoned their ordnance to defend themselves. The F-105 was particularly vulnerable if forced to maneuver at relatively low speeds. (6:234)

The clear advantage provided to North Vietnam by the various bombing halts is shown in Figure 1. The five-fold increase in MIG-21s, the introduction of the MIG-19, and the eight-fold increase in total inventory during the bombing halt from 1968 to 1972 are particularly dramatic. Throughout the war the North Vietnamese repeatedly demonstrated their ability to re-equip, retrain and develope new tactics during these quiet periods and after they suffered heavy losses. (2:141)

From the EW viewpoint, the most important aspect of the air-to-air battle was the heavy North Vietnamese reliance on a rigid but effective GCI system. The literature reveals no evidence that the North Vietnamese interceptors ever used airborne radars to detect and attack our forces. Instead,

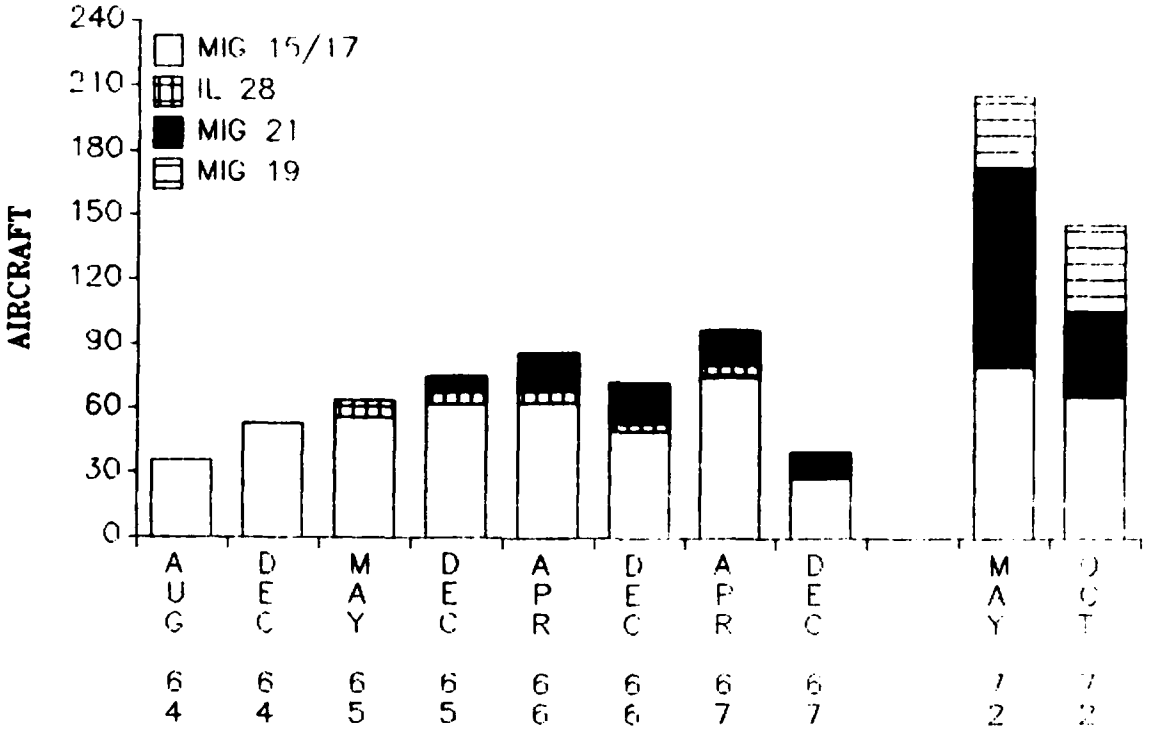


Figure 1. North Vietnamese Combat Aircraft Inventory: 1964-1972. (2:143)

the network of ground-based surveillance and height-finding radars described earlier were linked to GCI operators who showed much talent and ingenuity at the start of the war and who grew in skill through the war years. By war's end, these GCI operators were able to take full advantage of their radar system, the extensive SAM and AAA defenses, and stereotyped U.S. tactics to pick exactly the right moment to strike. As we will see below, this GCI system became an important target for U.S. electronic countermeasures. (6:231; 2:143-144)

The AA2 ATOLL infrared homing missile was the only known air-to-air missile used by the North Vietnamese. This

heat seeking missile, which closely resembles the American AIM-9B SIDEWINDER, was first used by the North Vietnamese in late 1966. Not surprisingly, the addition of this capability brought a trend toward increased aggressiveness on the part of North Vietnamese pilots. Using high-speed tactics and working in with MIG-17's, the North Vietnamese forced American airmen to revise their tactics and increase reliance on fighter escorts for their fighter/bombers. (2:144) Although the MIG-21 also can be armed with a radar guided "Advanced ATOLL", there is no indication that these missiles were provided by the Soviet Union for use in the war. (16:235)

# CHAPTER III

## ELECTRONIC WARFARE OPERATIONS

The EW challenge of the Vietnam war caught the United States unprepared, ill-equipped and untrained for this aspect of air combat. EW was not a new phenomena. The histories of air combat in World War II describe numerous successful attempts to neutralize enemy radars and communications systems. In Europe, bombers were especially successful in countering German GCI and AAA radars with airborne jamming and chaff. (2:125)

The bomber force clearly benefitted from this experience. In the decade prior to 1965, SAC had pursued a program of development and acquisition to ensure that its bomber force could penetrate and survive the Soviet SAM system. The Soviet SA-2 was first detected in 1959 and by 1962 the U.S. had developed a bomber self-protection package to counter this missile and its radars. (9:72)

The fighter force was never overly concerned with EW. They were not seriously threatened by enemy electronic systems in Germany or Korea, and they were confident that small size and agility provided all the protection they needed. Thus, as the North Vietnamese air defense structure grew rapidly in the early war years, the fighters found themselves "scrambling" to stay competitive in an electronic air war.

## The Early War Years

The only factor that prevented disaster for the American fighter/bombers in the early months of the war was the relatively small and primitive air defense system the North Vietnamese possessed when the bombing began.

### Radar Homing and Warning (RHAW) Equipment

While the North Vietnamese modernized their air defense force, the U.S. fighter/bombers found ways to operate without an effective self-protection ECM package. As the SAM capability grew, pilots learned to rely on their RHAW gear for warning of SAM radar activation and launch of the missile. The RHAW gear also provided them a general idea of the direction of attack and the range to the missile so that they could take evasive action. (2:127-128) This equipment proved so effective that on 16 August 1965, the Air Force's 2d Air Division submitted an urgent request to increase the availability of RHAW gear and improve its performance. (9:74)

As the density of threat radars increased, the reliability of the RHAW gear decreased. The great number of SAM and AAA radars, usually in defensive concentrations, tended to saturate the equipment. By December, 1966, the commander, Seventh Air Force urgently asked Systems Command for help:

> We need new RHAW equipment. The ambiguity of present equipment has reduced their effectiveness significantly. With the number of SAMs being fired,.... the pilot needs to know which specific SAM is a direct threat to him. With current information, he has so many lights, it is impossible to do anything but wait and see what developes. (9:61)

There is no indication in the literature that the problem was corrected before 1973, although pilots continued to rely on their RHAW gear throughout the war.

Dedicated ECM Aircraft

While the enemy SAM and AAA threat was still maturing, the Air Force and the Navy relied on a dedicated ECM aircraft to jam enemy radars and GCI communications. The Air Force used the EB-66C as a penetrating, escort jammer that accompanied strike aircraft during early attacks. This technique proved very successful and more than compensated for the lack of sufficient RHAW gear or on-board jammers for the fighters. Unfortunately, the EB-66 did not have the speed, agility, or EW self-protection it needed to survive in dense SAM or MIG environment. By August 1965, it was forced to withdraw from the target area to serve as a stand-off jammer. (9:63)

In October, 1965, an improved ECM aircraft, the EB-66B BROWN CANDLE, joined the EW force. Because the B-model was capable of neutralizing all threat radars in the North Vietnamese inventory, it resumed escort jamming missions while the C-model monitored the effects of jamming

and served as a gap-filler from its stand-off location. The C-model also provided valuable SAM launch warnings and ELINT collection to support the EW campaign.

With the steady growth of the MIG and SAM threat, Air Force planners attempted to strike a balance between the EB-66's vulnerability and its great value to the striking force. By 1967, EB-66s entered the high-threat areas only on rare missions, and then with extensive SAM suppression aircraft and a protective escort, or MIGCAP. The results were worthwhile. One particular raid on 15 November, 1967, demonstrated that "... the proper orbit orientation, coupled with the opportunity to get close to the terminal threat, had an effect on the defensive system of a magnitude unacceptable to the enemy." (9:63)

The Marine Corps deployed an improved penetrating ECM aircraft, the EA-6A, to Da Nang in 1965. During the first months of the war, the aging EA-3B Skywarriors and EF-10B Skyknights had been the only dedicated ECM aircraft available to support fleet air operations. The EA-6A was a modification of the capable A-6 Intruder that had entered the war as a fighter/bomber earlier that year. Few details about EA-6A operations are available in the unclassified literature. With its superior speed and agility, the EA-6A was less vulnerable than the EB-66 and provided many valuable employment lessons to be used in the development of its more sophisticated successor, the EA-6B. (13:49,202)

## The ECM Capability Improves

It soon became obvious that the U.S. could not rely solely on escort jamming and must have effective EW self-protection in order for its fighters to succeed. The growing SAM and AAA threat took its toll on American fighter/bombers in the winter of 1965/1966 and American commanders were urgent in their pleas for a quick solution to this problem. Although the reasearch and development community produced the much-needed protection in less than 18 months- compared with 3-5 years for normal procurement- the response was still too slow.

### ECM Self-Protection Pods

In the early 1960's the USAF began tentative experiments with detachable self-protection jamming pods for its fighter aircraft, but sufficient emphasis was never given the project. Before micro-electronics, built-in ECM for these small aircraft was a difficult problem. Further, many fighter aircraft had no space for an ECM operator for the manual systems that prevailed at this time. Equally significant was a state of mind amoung fighter pilots that they did not need ECM gear as long as they could avoid SAMs by using speed and maneuver. After the first effective SAM attack in 1965, this opinion changed.

Early efforts toward fighter self-protection focussed on external ECM pods as a solution to the internal space problem. The first ECM pods entered the USAF inventory

in very limited numbers in early 1964. These QRC-160-1 pods covered radars in frequencies from 2,600 to 3,200mhz (E-band) with ineffective broadband jamming that was not aimed at any specific threat radar in this frequency range. (9:72)

Although unclassified accounts of this early ECM pod are sketchy, it seems that a few of these QRC-160-1 pods were brought to Vietnam before the first SAM engagements of July, 1965. The RF-101 photo reconaissance aircraft, that operated "alone and unarmed" over North Vietnam, received the pods in March, 1965, and flew their first combat missions with four pods per aircraft in May, 1965. This first experience with ECM self-protection was not satisfactory. The pods effectiveness was questioned, they suffered from inflight vibration, and were suspected of creating aerodynamic problems for the RF-101s. (19:33) After three months of combat, the pods were returned to CONUS for redesign. (9:72)

On 16 August 1965, less than a month after the first aircraft fell to a SAM attack, the commander of 2d Air Division initiated an urgent request to develope and procure an ECM self-protection package for fighter/bombers that would neutralize the SAM and radar controlled AAA force in North Vietnam. Air Force Systems Command responded on 15 September with a concerted effort to modify and test the QRC-160-1 pods to effectively counter the FANSONG B and FIRECAN radars. (9:72)

The Navy was better prepared for EW self-protection,

although very little information on the subject can be found in unclassified sources. The Navy was able to provide self-protection for its strike aircraft while the Air Force was still relying on dedicated penetrating jammers.(14:103) The Navy ALQ-51 deceptive jammming pod was already available when the Air Force removed unsatisfactory first versions of the QRC-160-1 pods from their RF-101s. The ALQ-51 proved effective against the FANSONG B, forcing it into manual-track mode, thus degrading its accuracy. It also worked well against the conical scanning FIRECAN radar that guided larger AAA guns. (19:33)

The Air Force received its first improved QRC-160 pods, designated the AN/ALQ-71, in December, 1966, almost a year and a half after the first U.S. SAM casualty. The new pods, which saw their first combat in January, 1967, were the result of an exhaustive development and testing program designed to quickly get a product to the field that was both effective and reliable. Intitially, 203 of the new ALQ-71 pods, along with maintenance and support equipment, were bought. Not until six months after first delivery were there enough pods available to provide sufficient protection for strikes in the high threat areas around Hanoi and Haiphong. (9:73)

The ALQ-71 soon was recognized as an "unequivocal success" that "...constituted a giant step forward in countering the SAM threat." (9:25) In one period shortly

after the pods were introduced. AAA was observed only twice in 19 missions and these two occassions were cases where the enemy used barrage fire or attacked a damaged aircraft whose jammers were not operating. (9:75)

American airmen quickly realized the great value of the ECM pods and developed a new set of tactics to capitalize on this new protection. Formation flying, even by fighters, took best advantage of the radiation pattern of the jammers. It was soon obvious that the minimum flight that could be adequately protected by the pods was four aircraft, although a strike force of sixteen provided excellent ECM protection and allowed the formation to break into four aircraft formations if the larger group was threatened by MIGs or SAM launches (2:127) These tactics were the major reason for the reduced "kill-rate" of the SA-2. (Figure 2) By 1972, the

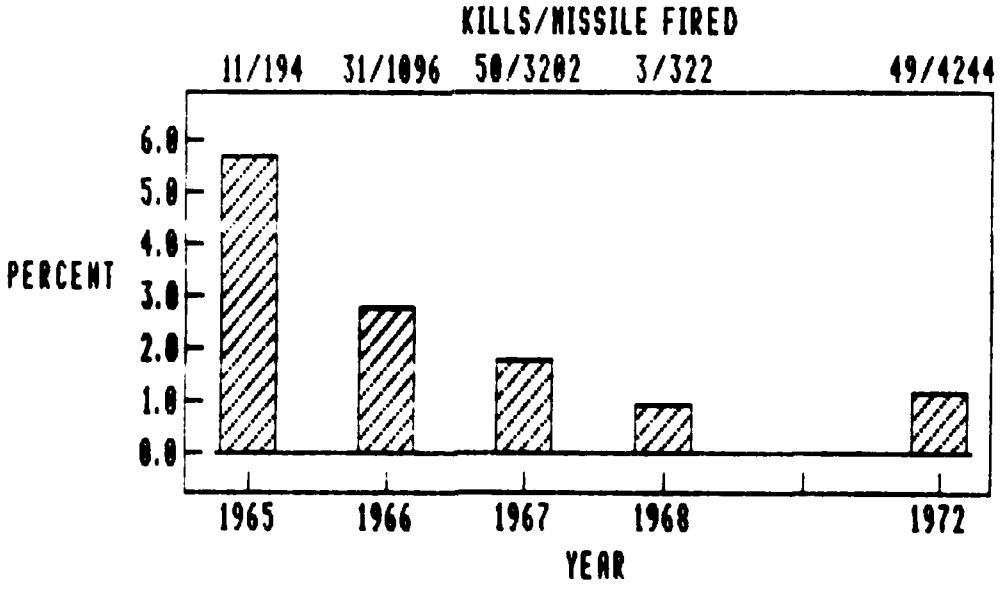


Figure 2. North Vietnamese SAM Effectiveness. (2:136)

North Vietnamese had to shoot 100 missiles to destroy one aircraft- a fivefold reduction in SAM effectiveness.

ECM Aircraft

The EB-66 and the EA-6 continued to provide valuable EW support to the strike aircraft operating over North Vietnam. In 1968, the Navy and Marines fielded a modification of the successful EA-6A that greatly enhanced their ability to protect strike formations. The EA-6B Prowler took full advantage of its survivability, and added a sophisticated electronics package that made it the premier ECM aircraft in the war zone. The crew was expanded from two to four with a 40-inch extension to the fuselage. This gave the Prowler two additional ECM operators to coordinate use of the improved and powerful jammers, an on-board computer, and a surveillance radar. The EA-6B proved so effective as an escort jammer that, though it has been kept current with the threat, it remains a key element of our airborne ECM capability today.(13:202-205)

The EB-66s also continued to provide dedicated ECM support, even though its vulnerability restricted its missions to a standoff role unless sufficient fighter escort could accompany them into high threat targets. Throughout the war, the EB-66s were particularly effective against the low frequency KNIFE REST and SPOON REST surveillance radars, though its performance against the improved BARLOCK was less impressive due to the BARLOCK's multiple beam operation.

Narrow beam, high powered height finders, such as the SIDE NET, were also less vulnerable to EB-66 jamming. (9:75)*

EW and Reconnaissance Operations

Because reconnaissance units normally operate in very high-threat areas without benefit of armed SAM and AAA suppression, their commanders and pilots are always looking for better ECM protection. Little wonder that the reconnaissance force was at the forefront of EW combat testing and experimentation.

The intitial experiments with protective ECM pods for reconaissance aircraft have been described earlier. The RF-101 continued for some time to use the ALQ-51 deception jammers borrowed from the Navy when the early QRC-160-1 pods failed to perform. When the RF-4C joined the reconnaissance force, they brought with them an improved jammer, the APS-107, that used noise jamming to fill the enemy radar scopes. As a result of this difference, whenever the RF-101 and RF-4C flew together over the same target area, the SAM operators fired more often at the RF-101. In June, 1967, RF-101s were the target of 72 percent of all SAMs fired. Reconnaissance aircraft must fly a steady, straight course in order to take useable imagery. Missions flown by RF-101s were often unsatisfactory because the aircraft frequently

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* Other models of the EB-66 saw service in Vietnam. A detailed analysis of their performance can be found in three sources, (20), (21), and (22).

would "jink" to avoid a SAM or AAA battery. The resulting imagery would not provide complete coverage of the target area. This problem, along with the tendency of the RF-101 to "draw" SAM fire, resulted eventually in a decision to only use RF-101s in low threat environments. (19:33)

The EB-66 and the EA-6 were frequently used to provide escort jamming for reconnaissance aircraft when the mission was to photograph high-value, high-threat targets. As early as January, 1967, Seventh Air Force began planning missions to ensure that the reconnaissance aircraft was in the target area while the jammer aircraft were there providing strike force protection. When the inability of the EB-66 to survive in high threat areas forced it into a stand-off jamming role, the effectivenss of the jamming decreased and the reconnaissance aircraft were forced to rely on self protection. (19:24)

Formation flying, with two reconnaissance aircraft in a team, was used to optimize jammer performance, provide MIG and SAM overwatch, and collect a second set of imagery to make up for any portion of the target lost to "jinking." This tactic, which was in contrast with traditional, "lone-wolf" tactics most reconnaissance pilots espouse, caused considerable debate in reconnaissance circles throughout the war. (2:234)

Reconnaissance units also led the way in the employment of chaff to screen their location on enemy radars.

Chaff had been shown to be effective in World War II when allied bombers dropped millions of the metallic strips to form "corridors" on the enemy radars through which the formation could safely pass undetected. Throughout the ROLLING THUNDER campaign, U.S. airmen suffered from an inability to fully use this simple ECM technique.

Initially, only the EB-66 could dispense conventional chaff, and the operational limitations placed on this aircraft have been described. Lacking a true chaff dispenser, RF-4C pilots found they could effect limited radar disruption by opening their speed brake, thus releasing bundles of chaff that had been stowed there before takeoff. Later, the 432 Tactical Reconnaissance Wing used explosive chaff cartridges, similar to their night flash cartridges. to dispense a very effective chaff cloud. This technique resulted in several documented "break locks" from both SAM and AAA radars. (19:25) Not until the air strikes of 1972 would the U.S. fully capitalize on the value of chaff.

## EW in LINEBACKER I and II

The lull in the air war that followed the cease-fire of 1968 gave both sides an extended opportunity to improve their capabilities, develope better tactics, and improve training for the next campaign. When full-scale attacks resumed in May, 1972, both sides were ready .

The North Vietnamese had rebuilt their air defense system, adding to its size and improving the coordination

between guns, missiles and interceptors. In the north, no new ground-based air defense weapons were introduced, but the enemy did make several key adjustments to improve effectiveness. An I-band variant to the guidance signal for the FANSONG radar was introduced that presented a new ECM challenge. Many FANSONG Gs, with an electro-optic guidance system, were introduced to reduce the effects of jamming. Although the acquisition of the infrared seeking SA-7 GRAIL in 1972 was a significant improvement, it seems they were never employed north of the DMZ.

The North Vietnamese interceptor force doubled in size from its April 1967 peak of 97 aircraft, with the bulk of the increase the addition of 81 MIG-21s and 33 MIG-19s, as shown in Figure 1. Many of the MIG-21s were improved versions with four air-to-air ATOLL missiles. (8:141; 2:143)

Improvements to the U.S. forces during this period were more in quality than quantity. By 1972, precision-guided munitions were in full use, changing many of the tactics used by the fighter bombers. SAM suppression tactics were refined and WILD WEASEL operations had become a routine part of each strike plan. Significant improvements were made to the ECM equipment carried by all U.S. aircraft.*

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* Very little unclassified information on these later EW measures are available. The declassified Project CORONA HARVEST reports covered the details of the air war only up to the cease-fire of 1968. Because much of the EW equipment fielded near the end of the war is still used in the force today, many of the details of EW in this last campaign of the war have not been declassified.

The F-4E Phantom II gave the Americans an improved SAM hunting capability. New ECM pods on the F-4E and other strike aircraft were able to "attack" the diverse frequencies of the North Vietnamese radars. Improved chaff dispensers were available on a variety of aircraft to capitalize on this simple but effective counter to GCI and SAM radars. (23:84; 8:259)

The unique nature of this phase of the war along with the improved capability on both sides, created a new and different EW challenge. For the first time, the full might of Strategic Air Command's B-52s was brought to bear against North Vietnam in massive night raids against Hanoi and Haiphong. To protect these large formations, a complete and sophisticated package of ECM and SAM suppression aircraft was carefully coordinated. Before each wave of B-52s, a wide corridor of chaff was created by F-4s with new dispensers. EB-66s and EA-6s jammed North Vietnamese GCI radars to prevent the entire air defense system from getting early warning of the attack. F-111s, newly returned to SEA after major improvements, along with F-105s, F-4s and Navy and Marine A-7s attacked SAM and AAA positions along the bomber route. (5:9)

The results of this coordinated effort were impressive. The bombing had a significant political and military impact on the North Vietnamese while only about 2% of the attacking force was lost, in spite of a massive North

Vietnamese defensive effort. (5:9) As many as 1,000 SA-2s were launched in the eleven days of LINEBACKER II. Only 15 aircraft were destroyed. So effective was the jamming of the GCI radars that on one occassion, a B-52 crew observed a MIG-21 that was apparently "escorting" the bomber formation providing heading, altitude and airspeed information to the confused defenders on the ground. (5:84)

By 1972, ECM self-protection had improved to the point that most aircraft, including the B-52s enjoyed some degree of on-board jamming. The B-52's size permitted the luxury of a sophisticated ECM suite, including an on-board EW officer to control the system and provide SAM threat warnings to the pilot. Even with this individual aircraft protection, the bomber force realized that ECM protection was greatly enhanced by formation flying. (5:47) The value of the ECM equipment became apparent when it was found that the B-52Gs, with an extensively improved ECM capability, were experiencing fewer losses and less damage than the same model aircraft that had not received the better EW gear. (5:87)

The SA-7 gave a new aspect to the electronic battle for the slow-moving forward air controller (FAC) aircraft, close air support fighters, helicopters and fixed-wing gunships operating in the south. The first SA-7 launch was detected in April, 1972, when a FAC reported "funny little black missiles following some of the fast movers off the target." (8:142) In the next few months the SA-7 took its

toll. Effective to an altitude of 10,000 feet, the SA-7 greatly inhibited full use of the fixed-wing gunships whose weapons has significantly less range. (8:195)

To counter the SA-7, gunships used their built-in illuminator flare dispensers to provide a "distracting" heat source for the heat seeker. When a crew reported a launch, a decoy flare would be released at the critical moment when it was apparent that the deception would be effective. (8:142) Although this technique worked occassionally, the gunship needed better protection. In September, 1972, improved wing-mounted flare dispensers were installed in C-130A and C-130E gunships. In the meantime, the research and development community was urgently seeking other solution to the SA-7 problem, including some form of launch detector, IR decoys, and heat suppressing paint surfaces. Helicopters tested heat diffusers to reduce the concentrations around engine exhausts that attracted IR seeking missiles. (12:246)

# CHAPTER IV

# EW LESSONS FROM VIETNAM

## Project CORONA HARVEST Reports

The CORONA HARVEST reports for U.S. air operations from January, 1965, to March, 1968, are an impressive compilation of the various experiences of units and individuals who conducted the operations. Thousands of these operational reports were consolidated by the Air University in 1972 and 1973 into a series of topical reports that evaluated the USAF performance in such disciplines as flight operations, reconaissance, command and control, intelligence, research and development (R&D), and personnel, amoung others. Each report included a summary of that aspect of the war and described specific lessons learned along with recommendations to the Air Force that would correct the deficiency.

A careful review of the CORONA HARVEST summaries revealed 24 recomendations specifically related to EW systems, doctrine, training, intelligence and R&D. Each CORONA HARVEST recomendation is supported by a detailed history and rationale along with a bibliography of supporting documents used to prepare the summary. Most CORONA HARVEST reports have been declassified under the automatic downgrading and declassification program. Because the

different reports were independently prepared, they often duplicate and, in some instances, contradict one another. Appendix B is a list of the 24 EW recommendations showing the source document for each.

The CORONA HARVEST summary reports thoroughly describe the air operations up to March 31, 1968, when President Johnson declared the bombing halt. Sadly, it appears that an equally thorough and detailed analysis of air operations since March, 1968, is not available. One short summary of air operations up to December, 1969, was produced but it is brief and contains little of value for EW lessons.(1) There is no indication that CORONA HARVEST reports on EW during the LINEBACKER campaigns were prepared, altnough several open source accounts of these operations are available.

## Electronic Warfare Lessons

An analysis of these documents and other sources previously cited in this study reveal the following EW lessons from the air war in Southeast Asia.

### Aircraft Self-Protection

The U.S. must provide reliable, effective ECM equipment for all fighting aircraft, including fighters, bombers, reconaissance aircraft, and helicopters. This EW equipment, which includes jammers, RHAW gear, and dispensers

for chaff and flares, should be designed as an integral part of the aircraft so that the ECM protection can be provided without effecting the ability of the aircraft to perform its mission. The equipment should be able to operate against any potential threat in an environment that is saturated with various radar signals.

To compliment this self-protection capability, a an escort jammer aircraft is needed to provide dedicated ECM protection for the strike force. This aircraft must be able to match the performance of the formation and must be able to survive in a high-threat SAM, AAA, and interceptor battle area. It must have sophisticated ECM gear that exceeds the capability and effectiveness of self-protection packages and can be updated to meet an improved or unexpected threat.

Doctrine and Tactics

The Vietnam War clearly showed that all services need to include EW in their warfighting doctrine. Because EW operations rarely involve a single service, this doctrine must have foundations at the joint level to ensure that the EW aspects of the campaign are properly conducted and mutually supportive.

All services need to develope a sound and effective set of tactics that takes full advantage of their EW capability and protective equipment. These tactics should be practiced and proven in realistic training environments.

they should be continually refined to meet new threat systems and tactics.

Training

Our pilots and aircrews must be able to train in a realistic electronic threat environment to be ready for the next war. They must frequently practice their tactics for using ECM equipment and they must be able to evaluate the performance of their crews, equipment and tactics in that threat environment. We must ensure that all officers, whether commanders or staff officers, are aware of the importance of EW and the role it plays in modern warfare.

Intelligence

Effective EW, like all other aspects of war, requires timely, accurate intelligence to be effective. The unique character of EW intelligence requirements demand, in many cases, dedicated collection assets that report directly to the key decision makers and EW planners. Specific technical information about an electronic threat system is critical to ensure that our forces are properly equipped and trained to neutralize that threat. At the same time, we need an accurate measure of the effectiveness of our ECM that will identify gaps in our effort and allow us to get full value from our EW assets.

Research and Development

EW R&D is a continuous process that cannot be ignored so long as the enemy is developing improved weapons systems. The R&D agencies of all services should be aware of the latest threat developments and search for better and cheaper systems to counter this new equipment. New EW systems must be tested in realistic threat environments and should be carefully evaulated for effectivness, reliability and supportability before fielding. Due to the unpredictable nature of EW development, our EW R&D community must be able to respond quickly to wartime improvements and new threat systems that appear in the battle area.

# CHAPTER V

## ARE THE DEFICIENCIES STILL THERE?

A complete, accurate assessment of our airborne electronic warfare capability for all four services would be difficult, even with unlimited resources and time. However, one inexpensive measure of our EW posture is available at the Air War College. Thirty-three students in the class of 1987 were assigned to flying units in the the past four years, either as commander or operations officer. The perceptions and opinions of these officers will provide a valuable sensing of the condition of the EW capability of our flying units.

The pitfalls of this methodology are obvious. The sample is small and opinions can be misleading if they are not based on facts. None the less, the perceptions and attitudes of these senior officers toward EW can give us some assessment of the EW system that is useful in the correct context.

### Survey Results

The consolidated results of the survey are shown in APPENDIX C. Weighted averages for each set of responses were used to identify a consensus. An ambivalent opinion was assigned if the mean response fell between 2.33 and 3.66. Any mean response outside that range was considered a consensus to that side of the opinion spectrum. Subjective

responses and comments were consolidated by category of respondent. In the description of the survey results, question numbers that are the basis for each observation are shown in brackets, i.e. [22].

Aircraft Self-Protection

Regarding ECM self-protection for aircraft, the responses of those surveyed revealed the following:

___ Only one of 33 respondents indicated that his aircraft did not have an ECM capability. The one exception was the commander of an F-4 unit with an interceptor mission in Europe.[3]

___ Eighty-five percent said their aircraft had flare and chaff dispensers.[4]

___ Only 61 percent reported that their ECM equipment was interchangeable or could be adjusted to meet changes in threat parameters.[10]

___ A significant number of respondents considered their ECM and RHAW gear to be reliable.[6,7]

___ However, the population was ambivalent about whether their ECM gear was adequate to meet the expected threat. Reconaissance pilots were particularly doubtful that their ECM gear was adequate.[9]

Doctrine

Responses to questions concerning EW doctrine revealed a curious contradiction:

___ Respondents professed a moderate familiarity with service EW doctrine.[23]

___ A similar response was made concerning how well the officers understood details of EW. While only a few respondents (9%) declared a "very limited knowledge" of EW, an equal number felt their knowledge of EW was "thorough."[16]

___ Curiously, a strong consensus felt that, although their knowledge of EW was limited, they knew enough to effectively command.[19]

___ Army, Navy and Marine Corps officers responded differently than their USAF peers to these three questions. All Army, Navy and Marine Corps officers professed a greater than average familiarity with EW doctrine and a better understanding of the details of EW.[18,19,23]

___ Respondents were ambivalent about the value of EW doctrine in planning and executing combat operations.[24]

Tactics

___ A consensus of respondents indicated that their unit had extensive tactics to counter the enemy electronic threat or enhance protective ECM. Only two officers, both interceptor pilots, indicated that their unit had no EW tactics. Army helicopter pilots unanimously indicated that they had extensive EW tactics, while the Navy and Marine Corps pilots showed a good consensus in that direction.[11]

___ A majority reported that these tactics were standardized or a mixture of standardized and self-developed tactics, with the bomber pilots showing the strongest degree of standardization.. Only 12 percent said their tactics were entirely self-developed. [13]

___ A solid consensus of all pilots who had EW tactics reported that they practiced these tactics often.[12]

___ A good consensus felt that their EW tactics usually worked, although reconaissance pilots showed less confidence.[16]

___ Respondents were ambivalent when asked whether their tactics had been tested in a realistic threat environment. Better than half the fighter pilots had tested their tactics against a valid threat simulation, but the bomber, reconaissance and Army helicopter pilots tended toward the "unrealistic" end of the spectrum.[17]

___ Only 27 percent of the pilots reported that their units relied on a penetrating ECM aircraft to accompany the strike formation.[14] As a result, only a few practiced these tactics often, Ninety-one percent reported that they had very rarely or never practiced the use of a penetrating jammer. Of those who relied on this tactic, two-thirds rarely practiced it. Only the Navy and Marine Corps seemed to use and practice this technique.[15]

Training

One of the most consistent opinions revealed by the

survey related to EW training. While most pilots felt their aircrews were adequately trained in EW principles and tactics [20], many respondents reported that the lack of realistic training in a valid threat environment was a serious deficiency.[21] Sixty-one percent of those responding did not feel their service had adequately integrated EW into their officer professional education program so that it produces knowledgeable commanders and aircrews who can use EW effectively.[22]

Intelligence

Only a small percentage of the respondents showed any confidence that the intelligence system would provide them accurate and timely intelligence to conduct their operations and, specifically, to conduct the EW campaign.[26a and 26b] Almost three-quarters of those surveyed indicated that a very small number of their officers held SCI access.[25]

Overall EW Posture

The 33 respondents were clearly ambivalent concerning the overall EW capability of their units.[27] Thirty-six percent expressed some degree of confidence that their EW capability would allow them to perform their mission without serious limitations. Thirty percent showed some doubt about this capability. Analysis of the the responses showed no clear pattern among sub-populations. Fighter and

bomber pilots were equally ambivalent, although the reconaissance and Army helicopter pilots showed a slightly greater tendency toward doubt.

Deficiencies From Vietnam

A similar ambivalency was found in responses to those questions on whether the deficiencies from Vietnam had been corrected.[28a,b,c] Combined responses to all three questions reveal that 32 percent felt we have corrected the defeciencies while 42 percent did not. Army helicopter pilots and USAF reconaissance pilots tended to lean toward the uncorrected end of the spectrum, while bomber pilots showed a tendency in the opposite direction, particularly in the area of training.

## Discussion of Results

Although the survey did reveal some interesting and useful opinions about our EW capability, it also showed a high degree of ambivalence concerning some key issues. Those surveyed could not agree that the EW systems and tactics their units used would allow them to perform their missions without serious limitation. Similarly, they could not agree on whether the errors of Vietnam had been corrected. While there are many possible explanations for these varied opinions, three factors cannot be overlooked. The diverse collection of aircraft, on-board EW systems and unit missions clearly influenced pilot responses. Officers who based their

opinions on experiences in an F-16 or F-18 unit obviously perceive a better EW capability than an officer in an F-10b or early F-4 unit. The variation of opinion between the different services also appeared important to the nature of the response. Marine Corps and Navy pilots tended to report a better EW situation in their units than in the other services, perhaps as a result of service emphasis. Officers from USAF interceptor and reconaissnce unit tended toward the negative end of the response scale, reflecting possible lack of emphasis on EW by these units. Lastly, one cannot ignore the possibility that many pilots develope a fondness for their aircraft that leads to a false sense of confidence in its ability to perform against any threat, including electronic weapons.

## Factors Not Addressed by the Survey

One of the inherent limitations of the survey was the fact that recent flying unit experience would not bring an officer into contact with certain aspects of EW and, thus, he would not know whether deficiencies in that part of EW have been corrected. EW R&D is just such an aspect of the subject that could not be assessed by the questionaire.

The lessons in EW R&D that Vietnam taught are all related to the very difficult problem of keeping ahead of threat technology. There is some indication in the open source literature that, although great strides have been made to improve R&D, we are still unable to develope and field up-

to-date technologies as quickly as new threat systems are fielded. EW systems are a perfect example of the great problem that frustrates all efforts in military R&D. The acquisition process is far too long to ensure that the new system will not be obsolete before it is fielded. The Airborne Self-Protection Jammer (ASPJ) was approved in August, 1980, to be the next built-in ECM protection package for our main-force fighter aircraft, the Navy and Marine Corps' EA-6B, A-6E, F-14, AND F-18'S, along with the Air Force's F-16.(25:22) Seven years later it is still far from fielding and in trouble with Congress because of costs, technology delays, and coordination between the services. (26:41) In those same seven years, the Soviet Union has fielded at least 3 new SAM systems, the SA-12 GLADIATOR, the SA-13 GOPHER, and the un-named SA-14. (27:136; 11:5.95)

New aircraft continue to come on line without adequate ECM protection. The B-1 bomber joined the SAC fleet in 1986 without the protection of the AN/ALQ-161 ECM package that was intended to counter some of the newer Soviet air defense systems. Early tests showed a fatal tendency to jam its own antennas. At least two years will pass before the B-1 will have adequate self-protection to fulfill its intended mission.(28:1,13)

There are positive aspects of the EW R&D program that should be mentioned. All services, to varying degrees, have developed an improved approach to R&D programming that

will reap benefits for future EW systems. The Department of Defense (DOD) Electronic Combat (EC) Master Plan gives direction and coordination to the development of all DOD EW systems of the future. (29:48) A similar document, the Army's Intelligence and Electronic Warfare (IEW) Master Plan will build a "single, coherent plan" that describes the Army's present EW capability, describes the electronic threat of the future, and developes a long-range (20-year) EW "architecture". (30). A similar Air Force EC Master Plan is being developed. (31:48)

A new atmosphere of interservice cooperation in EW planning is apparent when one hears officers of the Army and Air Staffs discuss the subject. The main intent of their work is to develope a cohesive package of EW initiatives that will convince Congress that our EW R&D effort makes optimal use of limited resources for the good of all four services.

# CHAPTER VI

# CONCLUSIONS

The analysis of unclassified documents and open-source literature, along with the results of a survey of former flying unit commanders and operations officers, reveals the following conclusions concerning EW in Vietnam, the lessons we learned from that aspect of the war, and the present condition of our EW capability:

## The War Experience

The North Vietnamese air defense system we faced during the war was extensive and well-coordinated but far from modern.

The U.S. strategy of gradualism, combined with extreme operational restrictions on our aircraft increased their vulnerability to air defenses and magnified the importance of EW.

The U.S. EW capability was not ready at the beginning of the Vietnam war but, over a period of almost 8 years, was able to develope a credible counter to the unsophisticated North Vietnamese electronic threat.

From the war the U.S. learned that it must have an EW capability to be able to operate effectively against a modern air defense system.

## The Present EW Capability

### Aircraft Self-Protection

The U.S. has not provided all fighting aircraft in our inventory ECM self-protection that does not impair the ability of the aircraft to perform its mission.

Although the U.S. has equiped its aircraft with limited, pod-mounted ECM, our pilots are confident that this gear will give them adequate protection to accomplish their mission.

### Doctrine

All services have included EW into their operational doctrine, although it is unclear how our middle-grade leaders and operators use this doctrine.

### Tactics

Aircrews from all services have a set of flying tactics they use to optimize the effects of ECM self-protection.

Aircrews regularly practice these tactics and they are slowly being standardized throughout the force.

Crews are confident that the tactics will work, but are concerned that they do not have enough opportunities to test them in a realistic environment.

### Training

Our flying crews in all services are trained in the

general principals of EW but do not regularly practice their techniques in a realistic threat environment.

The force rarely practices EW procedures with other flying units and, in particular, with dedicated ECM aircraft such as the EF-111 or the EA-6B.

Intelligence

Although great progress has been made in improving our intelligence collection capability, flying unit commanders are not confident they will have the intelligence they need in order to fight in an electronic environment.

All services need to concentrate further on inproving the intelligence support to tactical commanders to correct this lack of confidence.

The intelligence system should develope programs to give pilots necessary technical details of the electronic threat and enemy air defense tactics.

Our EW Capability

Although all EW deficiencies, such as those identified in Vietnam, may never be totally eliminated, the war experience has clearly convinced all services that EW is now a critical part of battle that cannot be ignored, either in peacetime or in war.

# CHAPTER VII

## FUTURE DIRECTION FOR EW

The problem of electronic self-protection for combat aircraft will continue to challenge our planners and developers in the future. While micro-electronics are helping with the problem of size for built-in EW systems, the diversity of the threat will continue to grow and create even greater space demands for the ECM package and its antennas. Already, the ASPJ program is in jeopardy because of its inability to keep up with the threat while holding cost and volume to reasonable levels. As a result, there is a growing body of opinion in EW circle that on-board self-protection may not be possible against multiple threats of the future air defense system. Instead, they suggest that expendable decoys, remotely piloted vehicles and dedicated ECM aircraft are the only solution. (29:70-73) In the near term, AirLand Battle doctrine demands that we provide effective ECM for a growing number of aircraft, including the Army's helicopters, that must operate within the enemy's air defense system. This doctrine also makes interservice cooperation in the development of EW equipment and tactics a necessity.

With all the effort and dollars spent to acquire modern ECM equipment, we cannot afford to ignore the importance of training our aircrews in a realistic threat environment. We must pursue the development of EW simulators

that present a current and thoroughly realistic air defense threat to our airmen so that they can develope and evaluate their individual and unit tactics against this threat. These simulators must be available in sufficient numbers to allow crews to frequently use them. The occassional or rare opportunity at an expensive training center such as REDFLAG or the National Training Center is not sufficient.

The EW R&D community must continually probe the limits of technology to recognize threat trends and develope ways to counter them before a conflict begins. Particular attention should be paid to emerging threats that operate beyond the radio and radar portion of the electro-magnetic spectrum. Electro-optic and laser air defense acquisition and tracking systems, that present an entirely new set of ECM problems, may already be under development. Destructive countermeasures that use all portions of the electro-magnetic spectrum may also be the future for aircraft self-protection.

# APPENDIX A

# SAMPLE QUESTIONAIRE

NAME _____

BOx NUMBER _____

FORMER UNIT _____

INSTRUCTIONS:

1. Please complete the following questionaire providing impressions or opinions based on your recent experience in an operational unit.

2. Do not include classified information. If your response is classified we can discuss it later.

3. Remember, in most cases I am looking for opinions and impressions you formed as a commander or operations officer in the past four years. I am not overly concerned with specific facts or documented cases.

4. Formal responses are not necessary. Clear, self-explanatory notes will suffice.

5. You may want to review the entire questionaire before you begin writing your responses.

6. When you have completed the questionaire, pass it to me or place it in Box 53. I'll get with you later if we need to meet to talk over your input.

7. I need your response NLT 9 December to keep on schedule.

Thanks.

# QUESTIONAIRE

EQUIPMENT:

1. What aircraft did your unit fly?

2. What was your unit s combat mission? In what theater?

3. What protective ECM did your aircraft have?

4. Did you use chaff flare dispensers? If so, what kind?

5. Were all aircraft equipped with the same ECM gear? Describe any variations.

6. How would you rate the reliability of your ECM equipment?

| Reliable | | | | Unreliable |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

7. How reliable was your RWR gear?

| Reliable | | | | Unreliable |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

8. Did your unit ever use this EW equipment in a realistic environment? If so, describe the situation.

9. Was your EW gear adequate to meet the expected air defense and counter air threat?

| Adequate | | | | Inadequate |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

10. Was your equipment adjustable or inter-changeable to meet changes in the threat environment?

TACTICS:

11. How would you describe any specific tactics used by your unit to counter the enemy electronic threat or to enhance protective ECM?

| Extensive Tactics | | Limited Tactics | | Non-existent |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

12. How often did your aircrews practice these tactics?

| Often | | Seldom | | Never |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

13. Were these tactics self-developed or were they standardized for units of this type throughout the Air Force? If they were standardized, cite sources.

14. Did your unit rely on dedicated ECM aircraft to protect the formation? If so, what aircraft?

15. How often did your unit practice using a dedicated ECM aircraft?

| Often | | Seldom | | Never |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

16. In general, did your EW tactics work?

| Usually | | Seldom | | Never |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

17. Was a realistic electronic threat environment used to test these tactics?

| Realistic | | | | Unrealistic |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

TRAINING AND DOCTRINE:

18. When you took command, how thoroughly did you understand the details of electronic warfare as they applied to the combat operations of your unit?

| Thorough Knowledge | | Limited Knowledge | | Very Limited Knowledge |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

19 At this point, you knew enough about EW to effectively command.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

20. Your aircrews were adequately trained in EW principles and tactics.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

21. What EW training shortfalls have you observed?

22. The USA/USN/USMC/USAF has fully integrated EW into its PME program to produce tactical commanders and aircrews who understand how to use EW as a combat multiplier.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

23. Are you familiar with the USA/USN/USMC/USAF doctrine concerning EW?

| Very Familiar | | Barely | | Never Read It |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

24. This doctrine was helpful in planning and executing combat operations in your unit.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

INTELLIGENCE SUPPORT TO EW OPERATIONS:

25. How many of your officers had SCI access?

| All | | Few | | None |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

26. How confident are you that the current intelligence system will:

.....provide you the timely, all-source intelligence you need?

| Confident | | | | Doubtful |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

.....provide you accurate, timely intelligence to support the Electronic Warfare campaign?

| Confident | | | | Doubtful |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

GENERAL:

27. Are you confident that the EW capability of your unit will permit you to perform your mission without serious limitations?

| Confident | | | | Doubtful |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

28 Has the USAF corrected the EW deficiencies identified in the Vietnam war? See cover letter for details of deficiencies.

| | Deficiency | Corrected | | | | Remains |
|---|---|---|---|---|---|---|
| a. | Inadequate EW protection for aircraft. | 5 | 4 | 3 | 2 | 1 |
| b. | Inadequate EW doctrine and tactics. | 5 | 4 | 3 | 2 | 1 |
| c. | Insufficient EW training. | 5 | 4 | 3 | 2 | 1 |

Use the space below to explain your responses or make further comments:

## APPENDIX B

## CORONA HARVEST RECOMMENDATIONS

| | Recommendation | Source |
|---|---|---|
| | ELECTRONIC WARFARE SYSTEMS: | |
| 1. | Develope EW systems for tactical aircraft that will allow single aircraft self-protection and full performance using interchangeable electronics. | (9:60) |
| 2. | Design passive EW systems (RHAW, SHRIKE Sensors, RIVET TOP) for high density radar environment. | (9:61-62) |
| 3. | Develop a high performance aircraft for penetration ECM missions as an interim until full self protection is available. | (9:63) |
| 4. | Develop effective ECM protection for the B-52. | (9:64-65) |
| 5. | Study/test best types of chaff for recce. | (9:25) |
| 6. | Get protective ECM to allow recce to fly straight, level missions. | (9:32) |
| 7. | Develope an effective self protection EW package for the WILD WEASEL. | (9:68-69) |
| | DOCTRINE: | |
| 8. | Develope joint tactical EW doctrine, tactics and equipment. | (21:66) |
| 9. | Test/study/develop joint jamming and recce tactics to optimize recce. | (19:24) |
| 10. | Revise AFM 2-1 to give doctrinal recognition to EW consideratons. | (9:59) |
| 11. | Revise AFM 2-1 to include special mission aircraft. | (9:68-69) |

INTELLIGENCE:

12. Get a tactical intelligence capability that provides timely, accurate intelligence to support the EW operation. (9:31-32)

13. Develope a capability to evaluate ELINT and translate it into useful EW information. (9:66)

14. Retain the capability to evaluate EW operations and assign skilled people to the job. (9:70-71)

15. Develope a capability to get all-source intelligence to commanders in a timely manner. (9:70-71)

16. Develope a capability to anticipate changes in threat. (9:25,72)

17. Get timely EW effectiveness evaluations to commanders. (22:65)

RESEARCH AND DEVELOPMENT:

18. Test EW equipment for reliability, supportability and effectiveness before fielding. (9:74)

19. Vigoursly pursue EW R&D to ensure that our capabilites match the next generation air defense threat. (9:75)

20. Retain the capability to conduct expedited EW development programs. (23:44)

21. Make survivability, including EW, a major consideration in initial aircraft design. (23:50)

22. Test and develope EW systems in a realistic threat environment. (23:63)

23. Retain the QRC procedures used during SEA air operations to develope EW systems. (23:69)

TRAINING:

24. Give EW considerations greater attention in PME schools, as well as in planning and operations at all levels. (9:59)

# APPENDIX C

# OPINIONS

# OF

# FORMER COMMANDERS AND OPERATIONS OFFICERS

EQUIPMENT:

1. What aircraft did your unit fly?

RESPONSES:

Fighter Aircraft:

F-4E - 5
F-4J/S- 1
F-15 - 3
F-16 - 1
F-18 - 1
F-106 - 1
A-6E -1
A-7E -1
A-7D -1
A-10 -3

Army Helicopters:

AH-1S
OH-58C )2
UH-1H

UH-60
UH-1
CH-47 )1
OH-59

Bombers:

B-52G/H -8
FB-111 -2

Reconaissance:

RF-4C - 2

2. What was your unit's combat mission? In what theater?

RESPONSES:

Fighters:

Air-to-air - 7
Air-to-ground - 7
Multi-role - 4

Army Helicopters:

Attack - 2
Assault - 1

Bombers:

Strategic - 8
Deep Interdict- 2

Reconaissance - 2

3. What protective ECM did your aircraft have?

RESPONSES: This question drew varied answers that indicated in some cases a lack of familiarity with the ECM equipment.

___ 98% indicated that their aircraft had ECM equipment.

___ Only 2% indicated that they did not have ECM equipment.

4. Did you use chaff/flare dispensers? If so, what kind?

RESPONSES: YES - 85% with various types.

NO - 15%

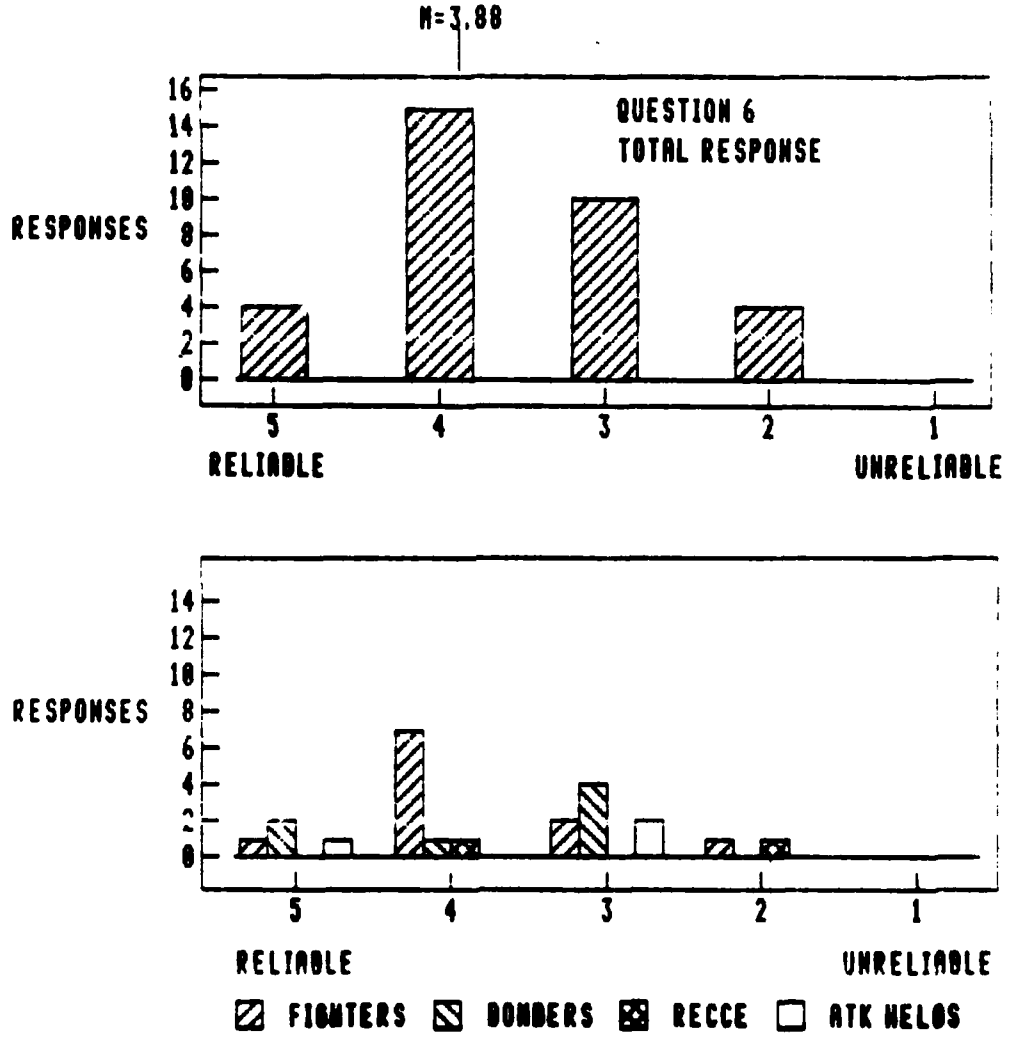
5. Were all aircraft equipped with the same ECM gear? Describe any variations.

| RESPONSES: | YES | NO |
|---|---|---|
| Fighters | 17 | 1 |
| Bombers | 8 | 2 |
| Recce | 2 | 0 |
| Army Helo | 0 | 3 |
| Total = | 27 | 6 |
| | 81% | 19% |

6. How would you rate the reliability of your ECM equipment?

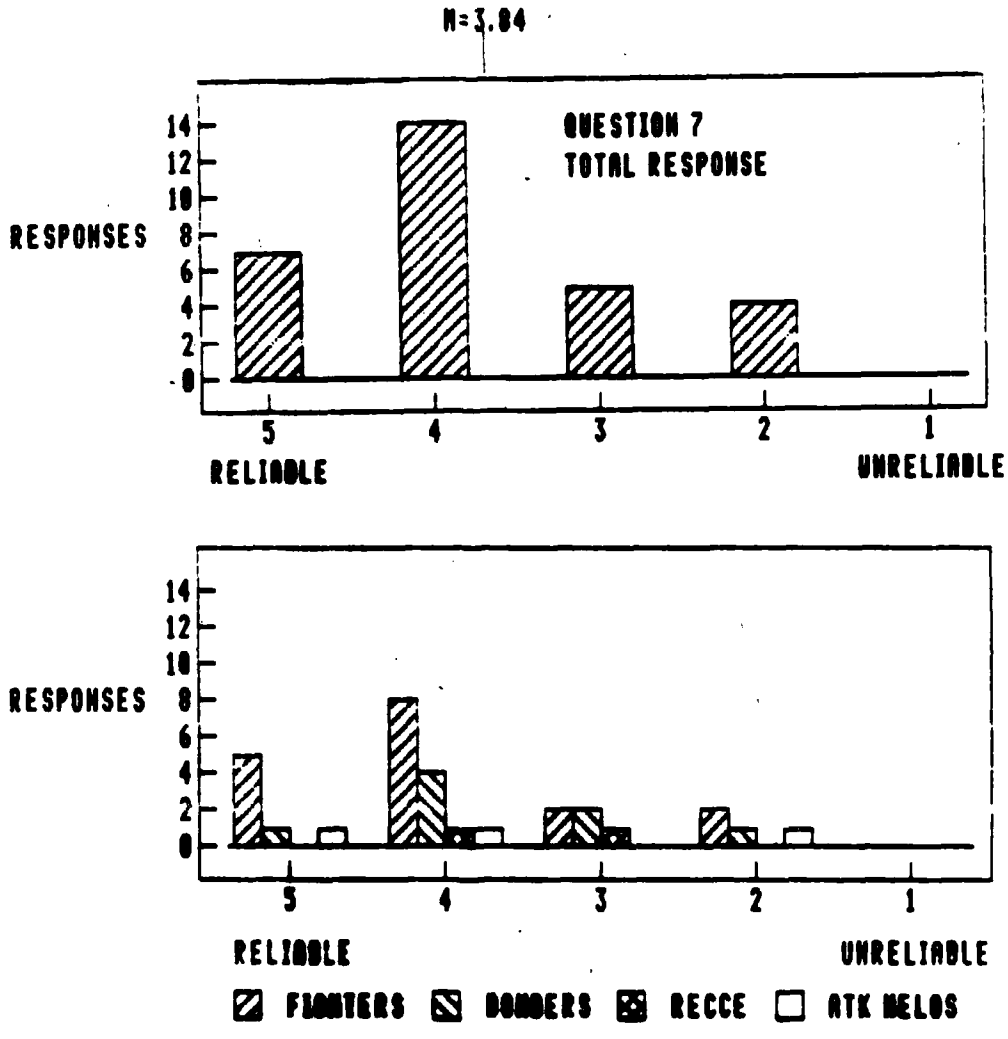
Reliable Unreliable

5 4 3 2 1



7. How reliable was your RWR gear?

| Reliable | | | | Unreliable |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |



8. Did your unit ever use this EW equipment in a realistic environment? If so, describe the situation.

| RESPONSES: | YES | NO |
|---|---|---|
| Fighters | 15 | 2 |
| Bombers | 8 | 2 |
| Recce | 0 | 2 |
| Army Helos | 3 | 0 |
| Total = | 26 | 6 |
| | 79% | 21% |

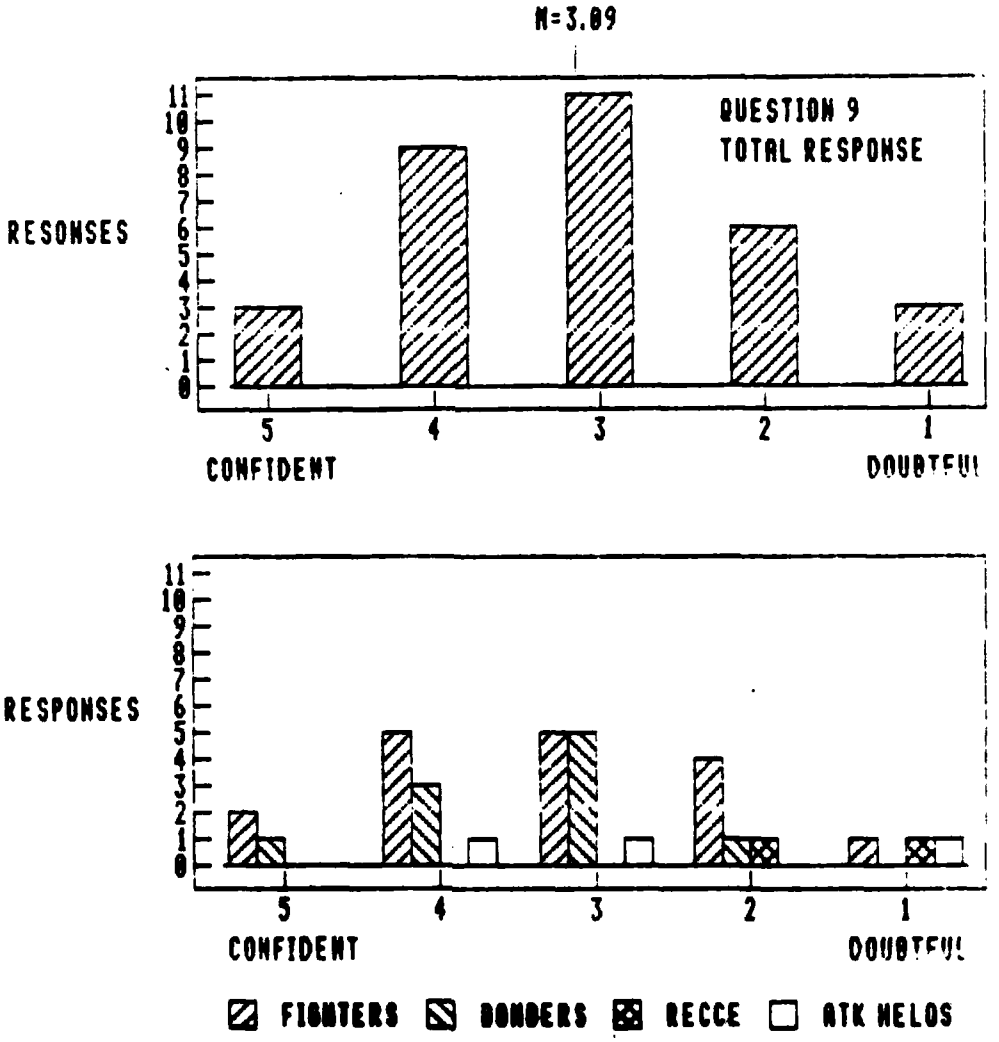
Examples:

| | |
|---|---|
| REDFLAG | GREENFLAG |
| MAPLEFLAG | Eglin EW Range |
| COPPERFLAG | Korean DMZ |
| BRIGHT STAR 85 | Sea of Japan Ops |
| Naval Strike Warfare Center, Fallon NV | China Lake Ranges |
| TEAM SPIRIT | COPE THUNDER |
| | Nicaraguan Border |

9. Was your EW gear adequate to meet the expected air defense and counter air threat?

Adequate Inadequate

5 4 3 2 1



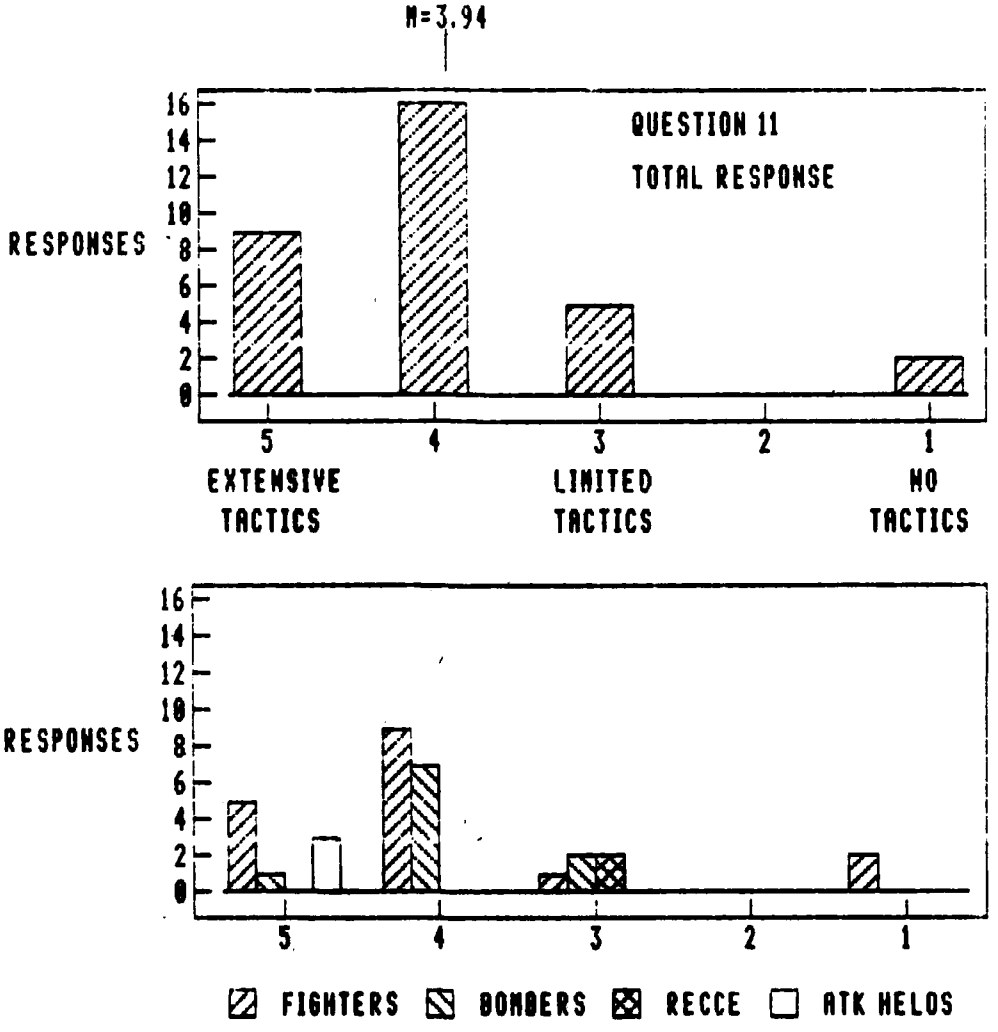
10. Was your equipment adjustable or inter-changeable to meet changes in the threat environment?

| RESPONSES: | YES | NO |
|---|---|---|
| | 20 | 12 |
| | 61% | 39% |

TACTICS:

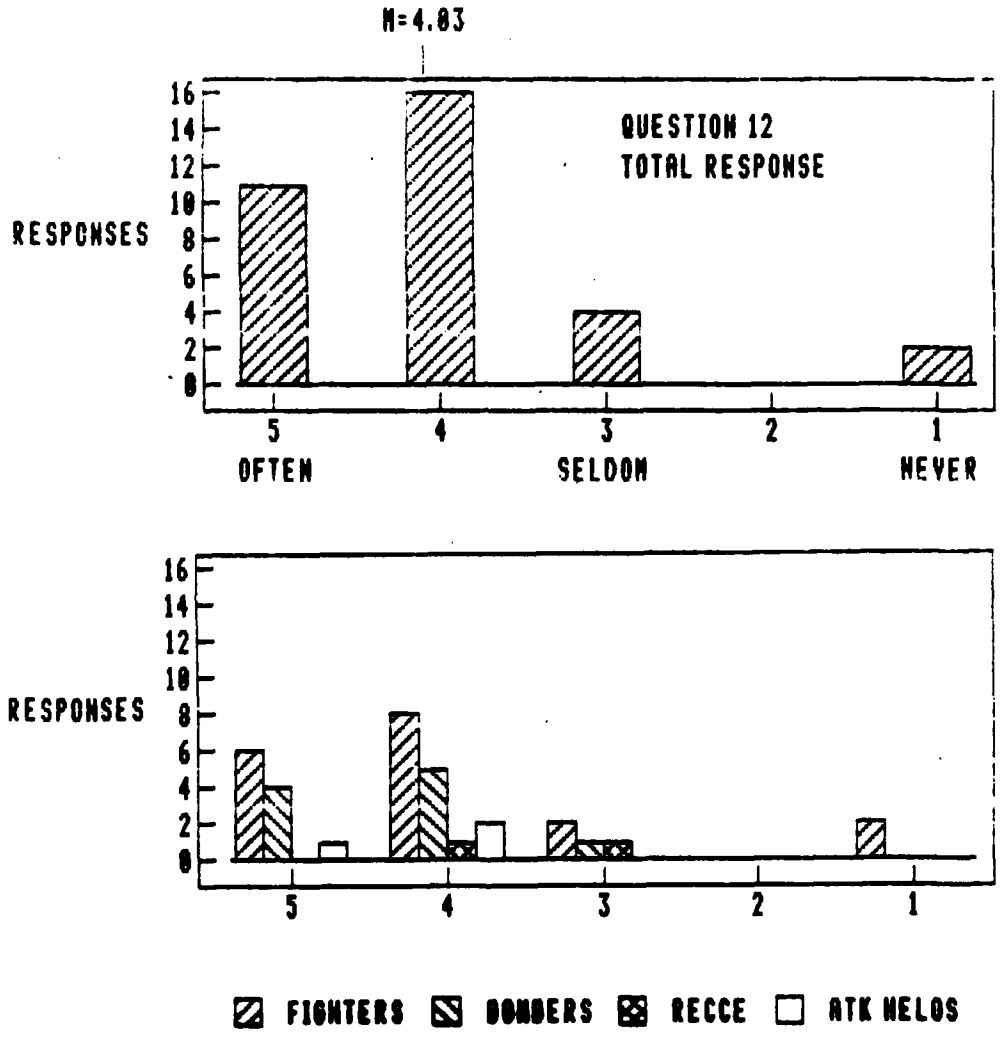
11. How would you describe any specific tactics used by your unit to counter the enemy electronic threat or to enhance protective ECM?

| Extensive Tactics | | Limited Tactics | | Non-existent |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |



12. How often did your aircrews practice these tactics?

| Often | | Seldom | | Never |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |



13. Were these tactics self-developed or were they standardized for units of this type throughout the Air Force? If they were standardized, cite sources.

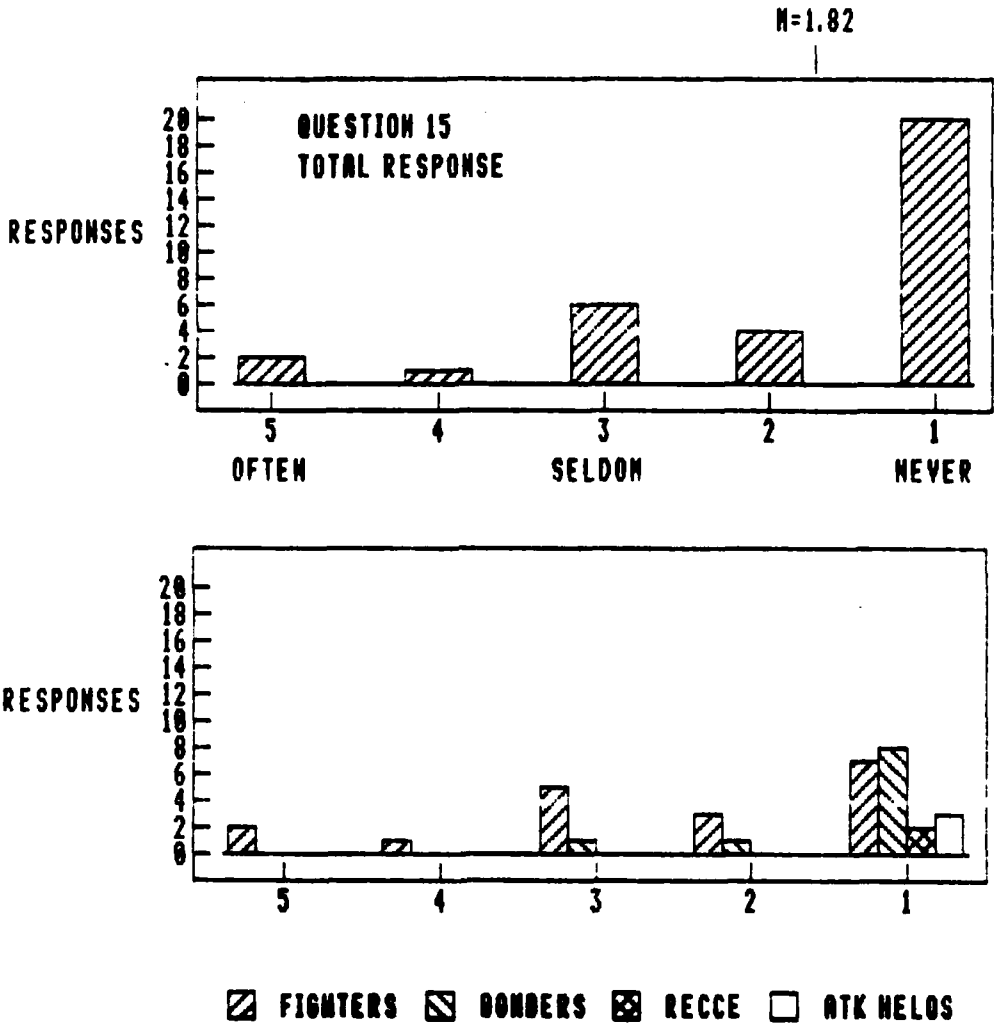
| RESPONSES: | YES | NO | PARTIALLY |
|---|---|---|---|
| Fighters | 1 | 8 | 7 |
| Bombers | 0 | 8 | 2 |
| Recce | 1 | 1 | 0 |
| Army Helos | 2 | 1 | 0 |
| Total= | 4 | 18 | 9 |
| | 12% | 55% | 27% |

14. Did your unit rely on dedicated ECM aircraft to protect the formation? If so, what aircraft?

| REAPONSES: | YES | NO |
|---|---|---|
| Fighters | 7 | 11 |
| Bombers | 1 | 9 |
| Recce | 1 | 1 |
| Army Helos | 0 | 3 |
| Total= | 9 | 24 |
| | 27% | 73% |

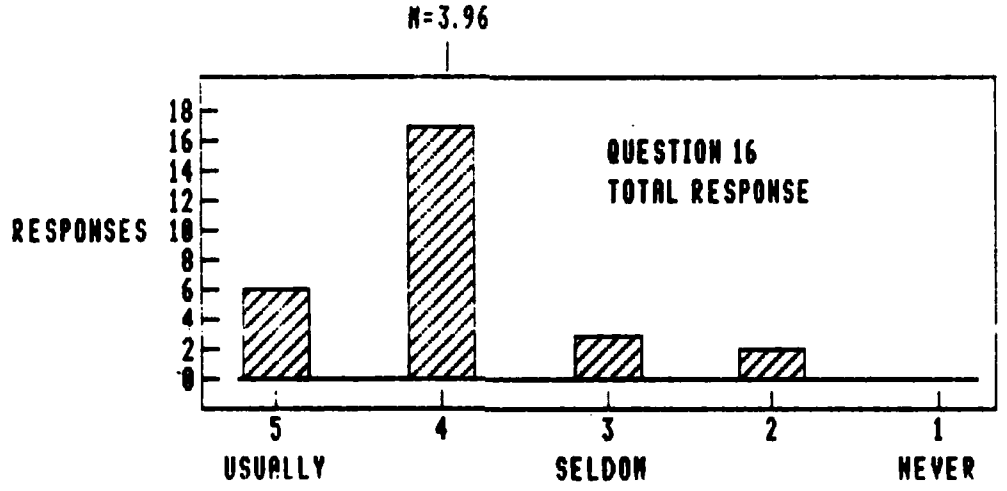
15. How often did your unit practice using a dedicated ECM aircraft?

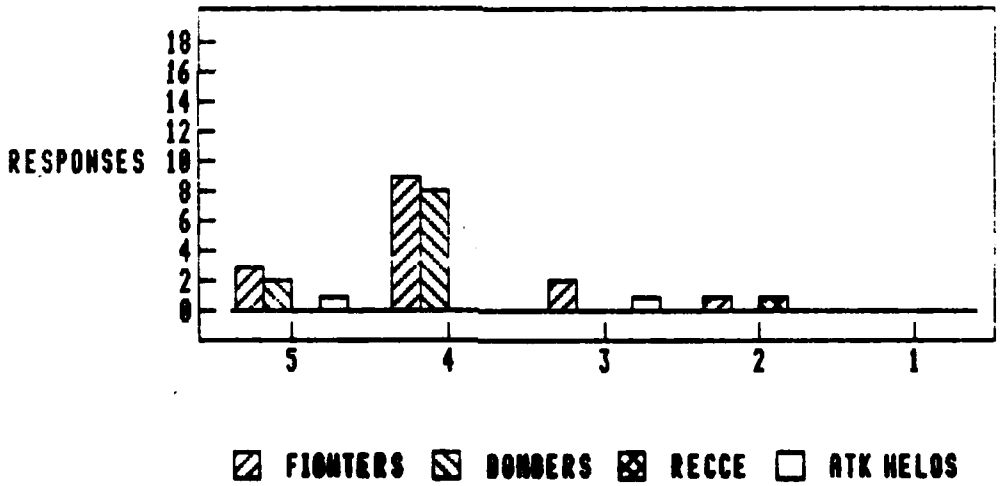
| Often | | Seldom | | Never |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |



16. In general, did your EW tactics work?

| Usually | | Seldom | | Never |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

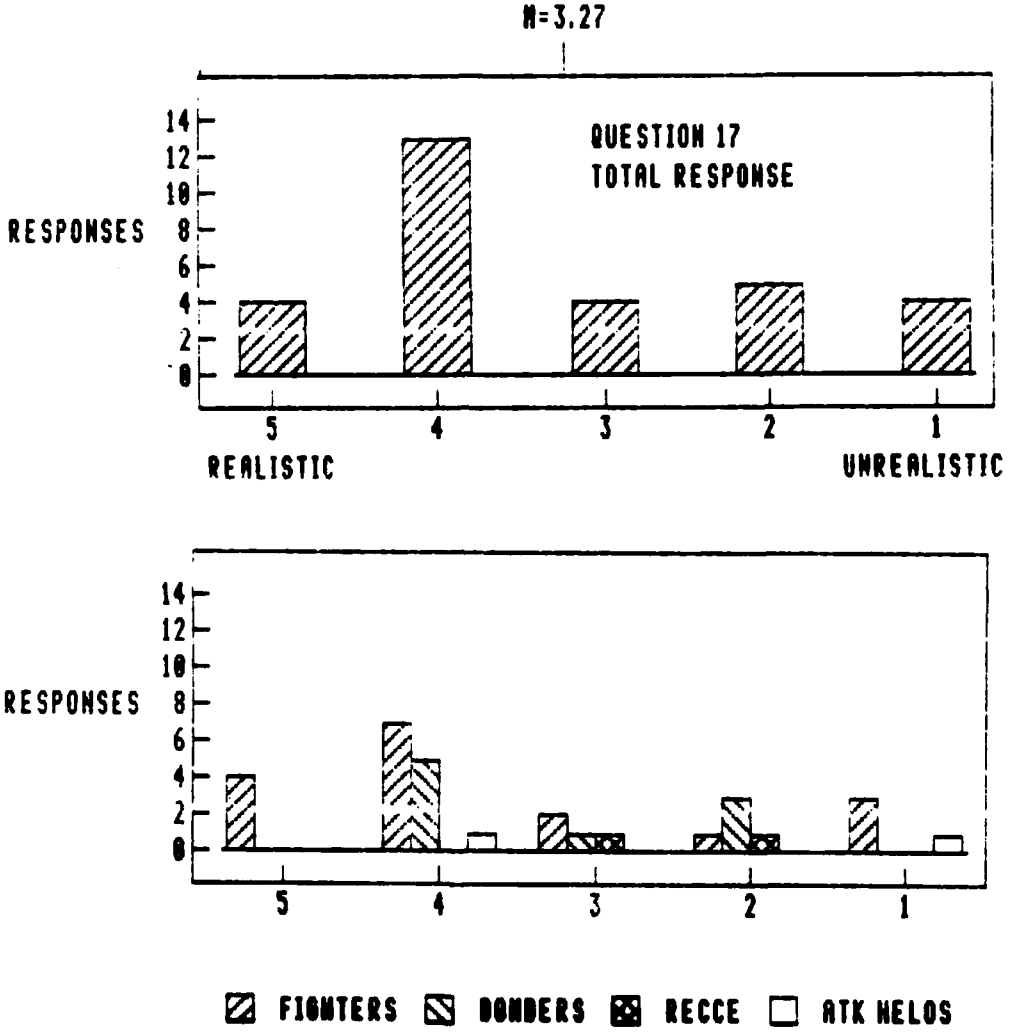


17. Was a realistic electronic threat environment used to test these tactics?

Realistic Unrealistic

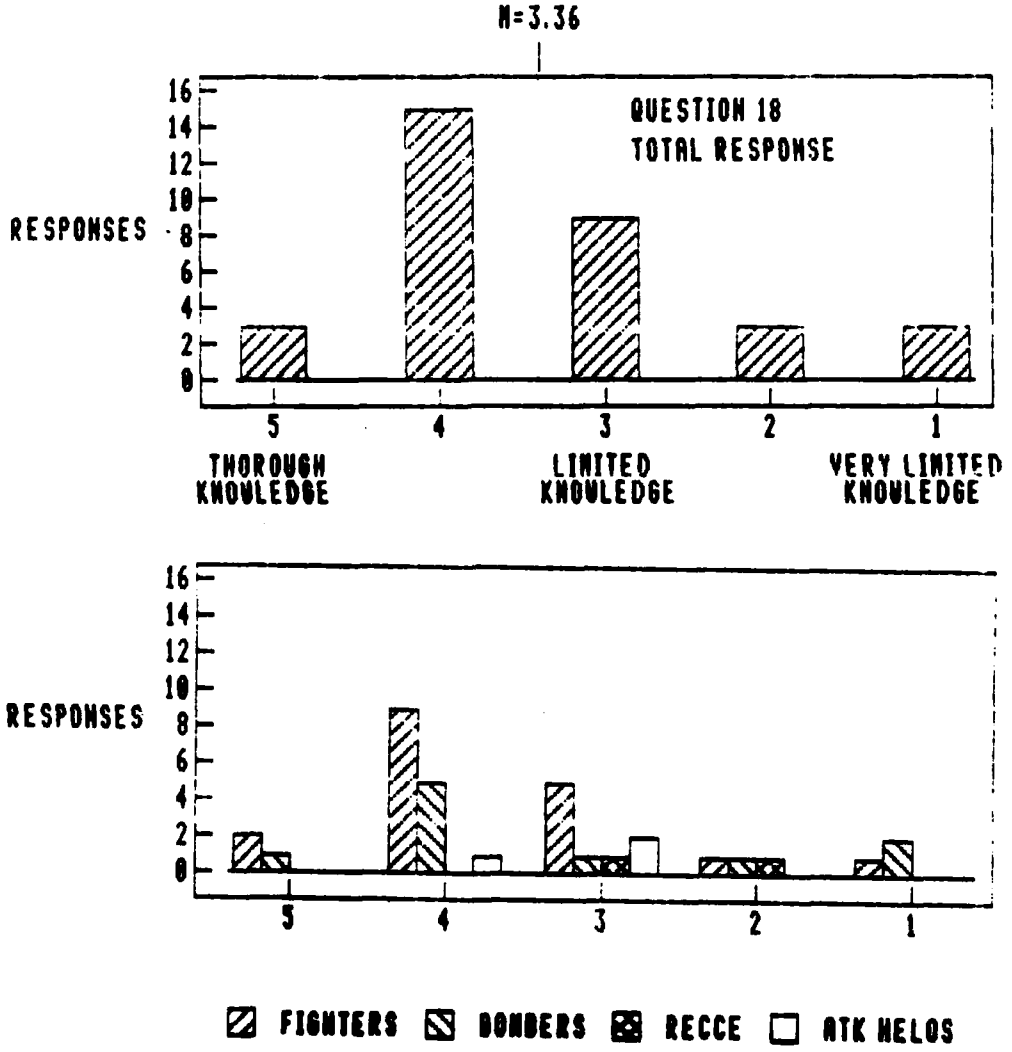
5 4 3 2 1



TRAINING AND DOCTRINE:

18. When you took command, how thoroughly did you understand the details of electronic warfare as they applied to the combat operations of your unit?

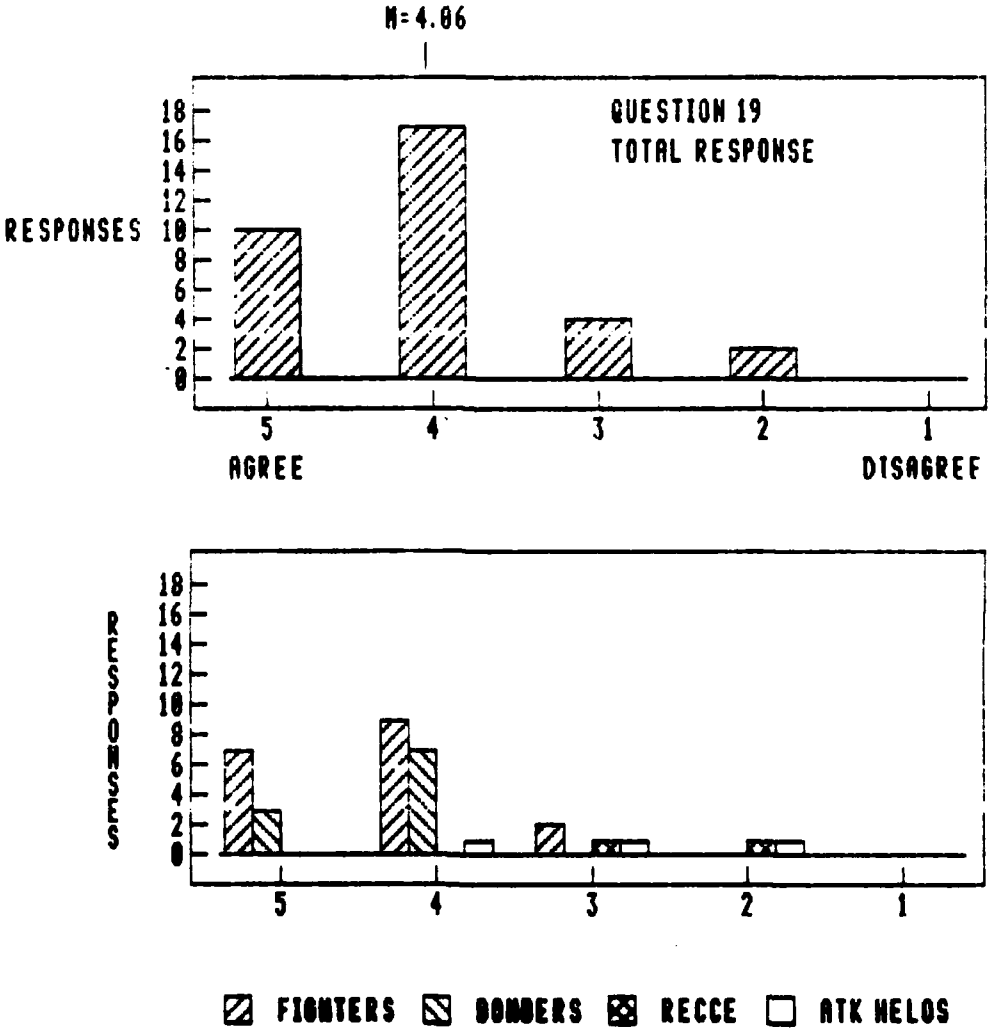
| Thorough Knowledge | | Limited Knowledge | | Very Limited Knowledge |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |



19 At this point, you knew enough about EW to effectively command.

Agree Disagree

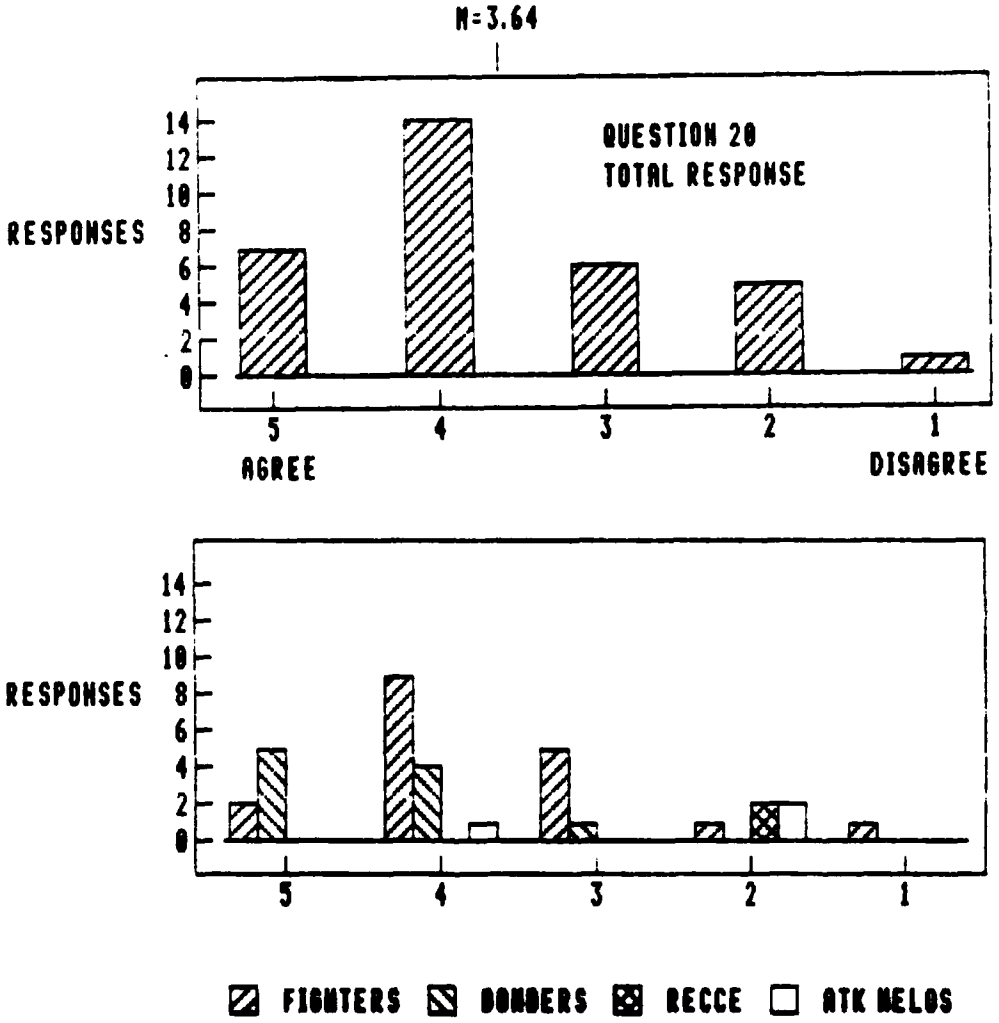
5 4 3 2 1



20. Your aircrews were adequately trained in EW principles and tactics.

Agree Disagree

5 4 3 2 1



21. What EW training shortfalls have you observed?

RESPONSES:

Fighters:

"Lack of available ranges where full-spectrum EW can be used."

"Lack of feedback on effectiveness of tactics/equipment during daily training."

"Flare plant burned down limiting training flares; ALE-40 deficiencies."

"Very little available on the interaction of the various EW platforms."

"Really haven't addressed how to use EW in a defensive, air-to-air environment."

"Training assets limited- i.e. targets."

"Not enough realistic training."

"Coordinated tactics with other air....& especially ground units."

"Not enough realistic threat emitters."

"ECM could not be used because it would comprimise its capability."

"Not enough EW ranges to train on."

"Insufficient number of aircrews trained in EW to be instructors or experts at the squadron and wing level."

"Exposure to more up to date threats."

"No chaff/flare dispensers."

"More knowledge about the threat would have allowed newly assigned pilots to be more effective."

"....we need to cycle all tactical air force crews through REDFLAG periodically ...."

"....we need updated threat simulators to portray realisitc combat environments from the Pacific and European regions."

"....FEEDBACK!! There are so few ranges that can grade tactics and pod performance that pilots only get to see them once every year or more often, every two years."

"The T-33 ECM capable aircraft to provide realistic training to air defense forces have been scrapped. Today there is no capability to realistically train F-106/F-15/F-4 air defense crews to counter ECM."

Bombers:

"Training ranges had old, outdated and inadequate gear to simulate all threats we could be subjected to during real-world missions."

"New ECM equipment installed in our aircraft could not be used in practice because of the non-availability of training equipment."

"We need more field-deployable simulators."

"Practice shortfall due to FAA problems."

"B-52 crew has little appreciation for the EWO's job."

"Realistic training."

Reconaissance:

"No realistic training with EW assets."

"Realistic ranges and reliable, up to date equipment."

Army Helicopters:

"Aircrews do not have the equipment to train with, therefore do not fully appreciate its (EW) value in the offense and its threat when used by the enemy."

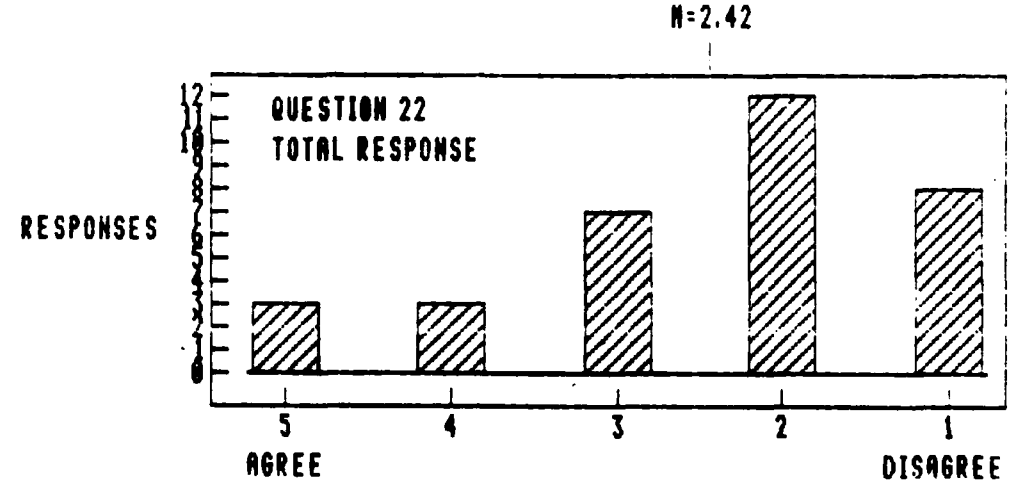
"Not enough training devices for aircrews to train with. You cannot train without a threat. To me this is the most serious deficiency we currently face."

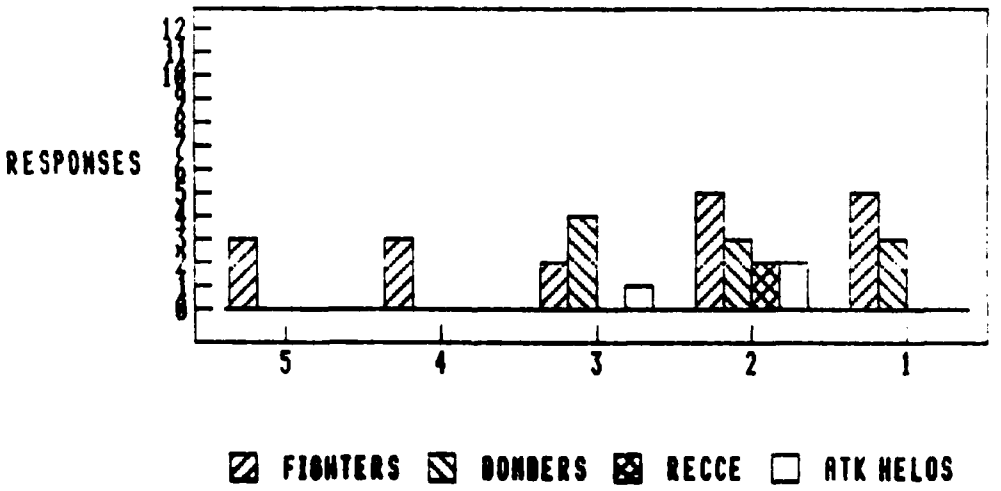
"(1) Understanding the threat.(2) Understanding the use of organic ECM gear. (3) Knowledge of our ECM limitations. (4) Training to correct the above."

22. The USA/USN/USMC/USAF has fully integrated EW into its PME program to produce tactical commanders and aircrews who understand how to use EW as a combat multiplier.

Agree Disagree

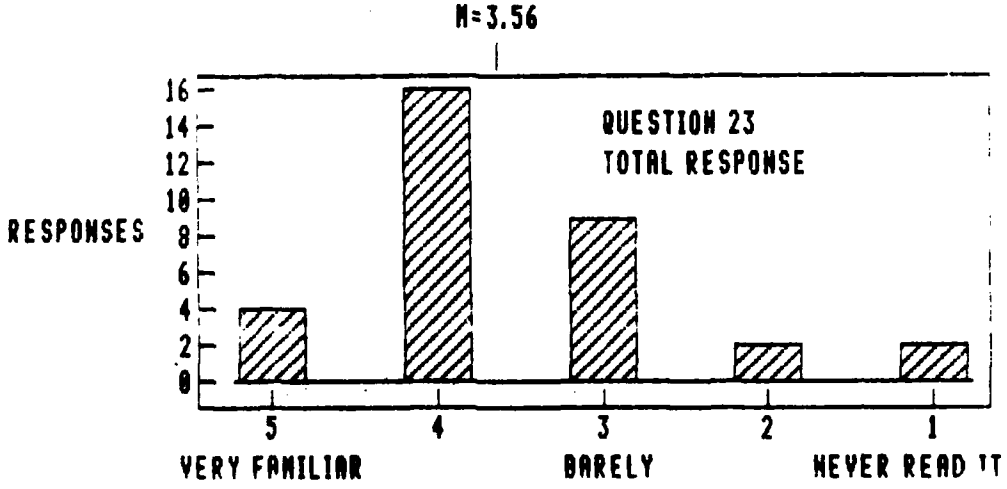
5 4 3 2 1

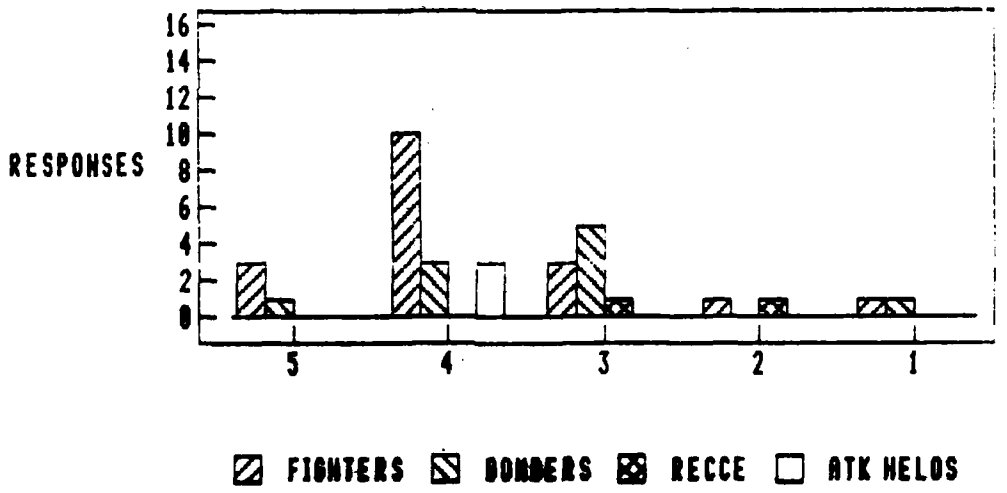


23. Are you familiar with the USA/USN/USMC/USAF doctrine concerning EW?

| Very Familiar | | Barely | | Never Read It |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

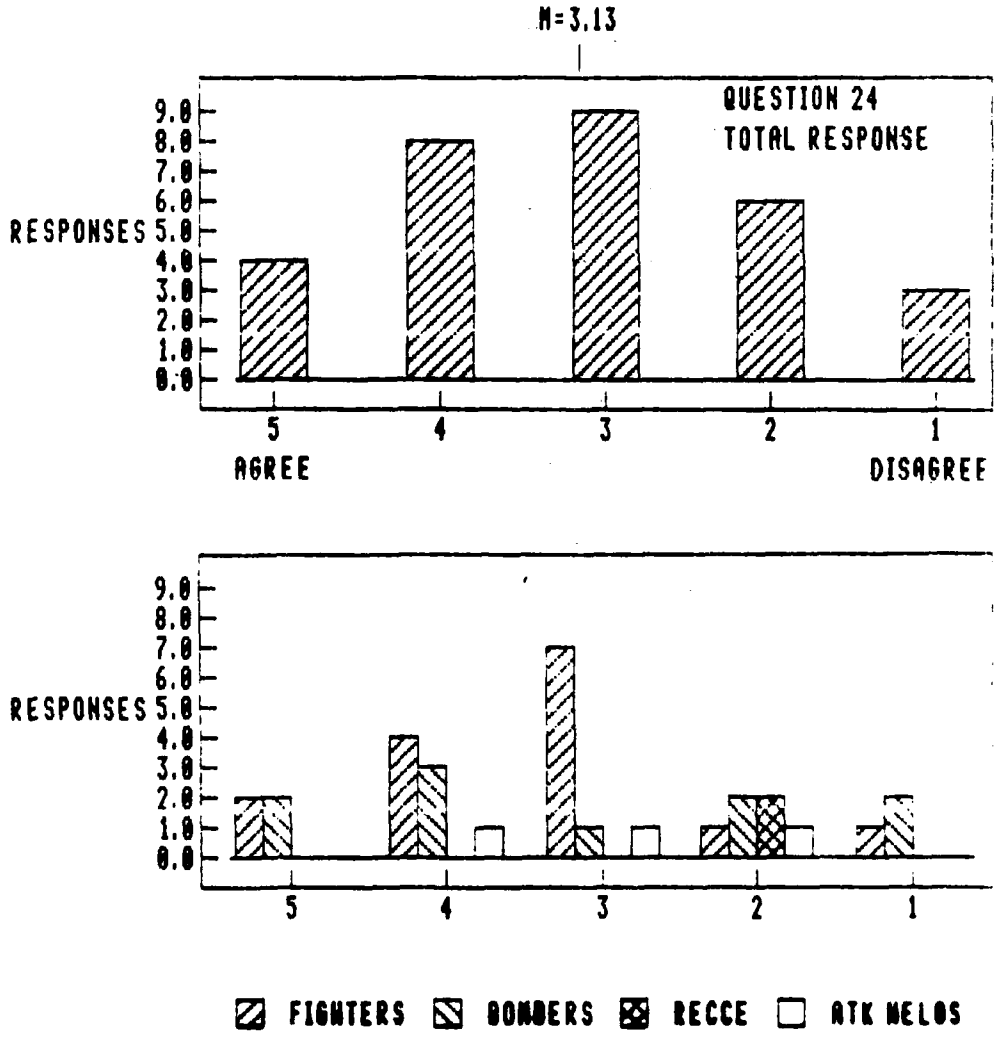


24. This doctrine was helpful in planning and executing combat operations in your unit.

Agree Disagree

5 4 3 2 1



AD-A186 626 ELECTRONIC WARFARE IN VIETNAM: DID WE LEARN OUR LESSONS?(U) AIR WAR COLL MAXWELL AFB AL J R DICKSON MAY 87 AU-AWC-87-053 2/2

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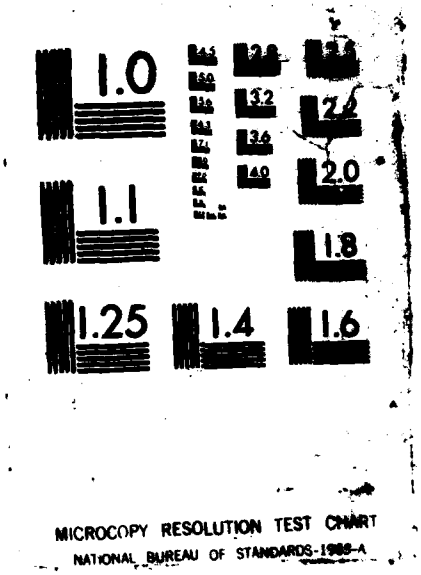
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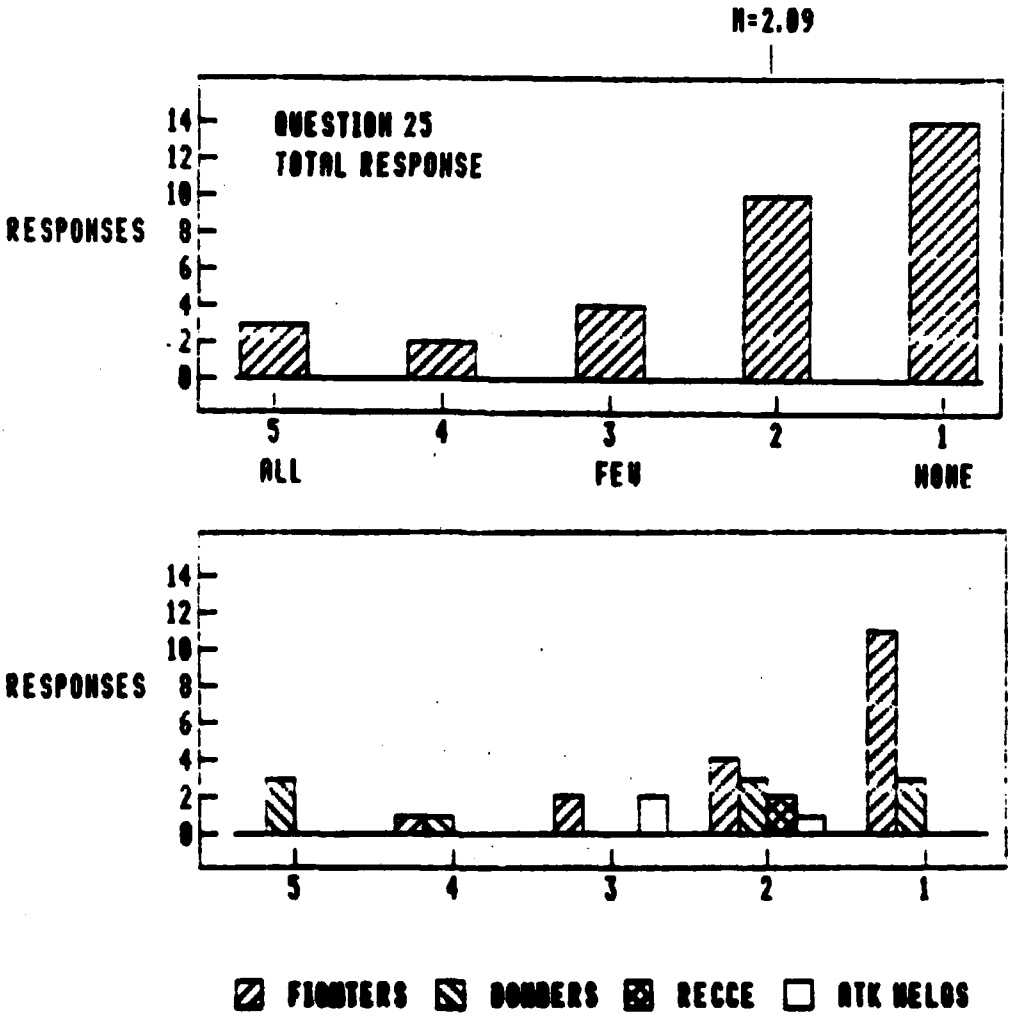
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

INTELLIGENCE SUPPORT TO EW OPERATIONS:

25. How many of your officers had SCI access?

All Few None

5 4 3 2 1

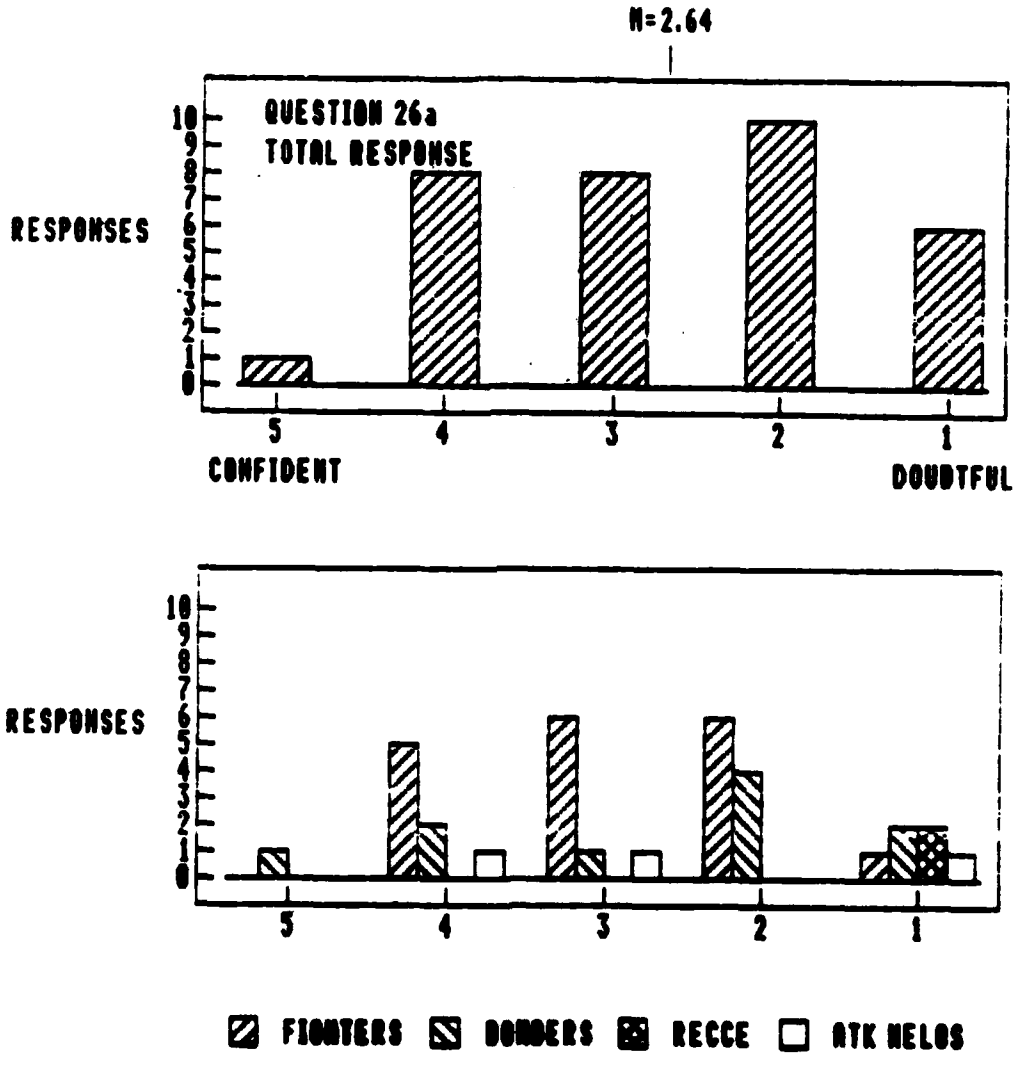


26. How confident are you that the current intelligence system will:

.....provide you the timely, all-source intelligence you need?

Confident Doubtful

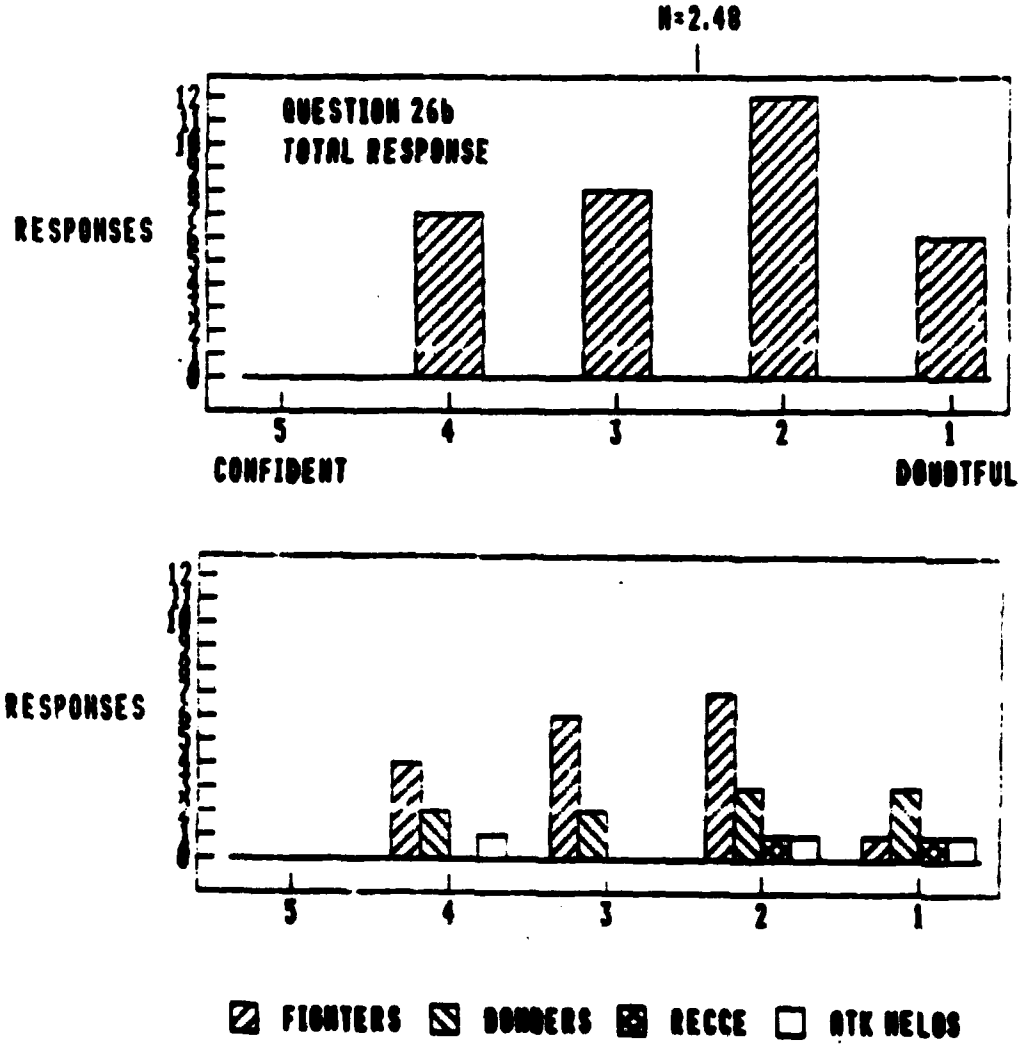
5 4 3 2 1



.....provide you accurate, timely intelligence to support the Electronic Warfare campaign?

Confident Doubtful

5 4 3 2 1

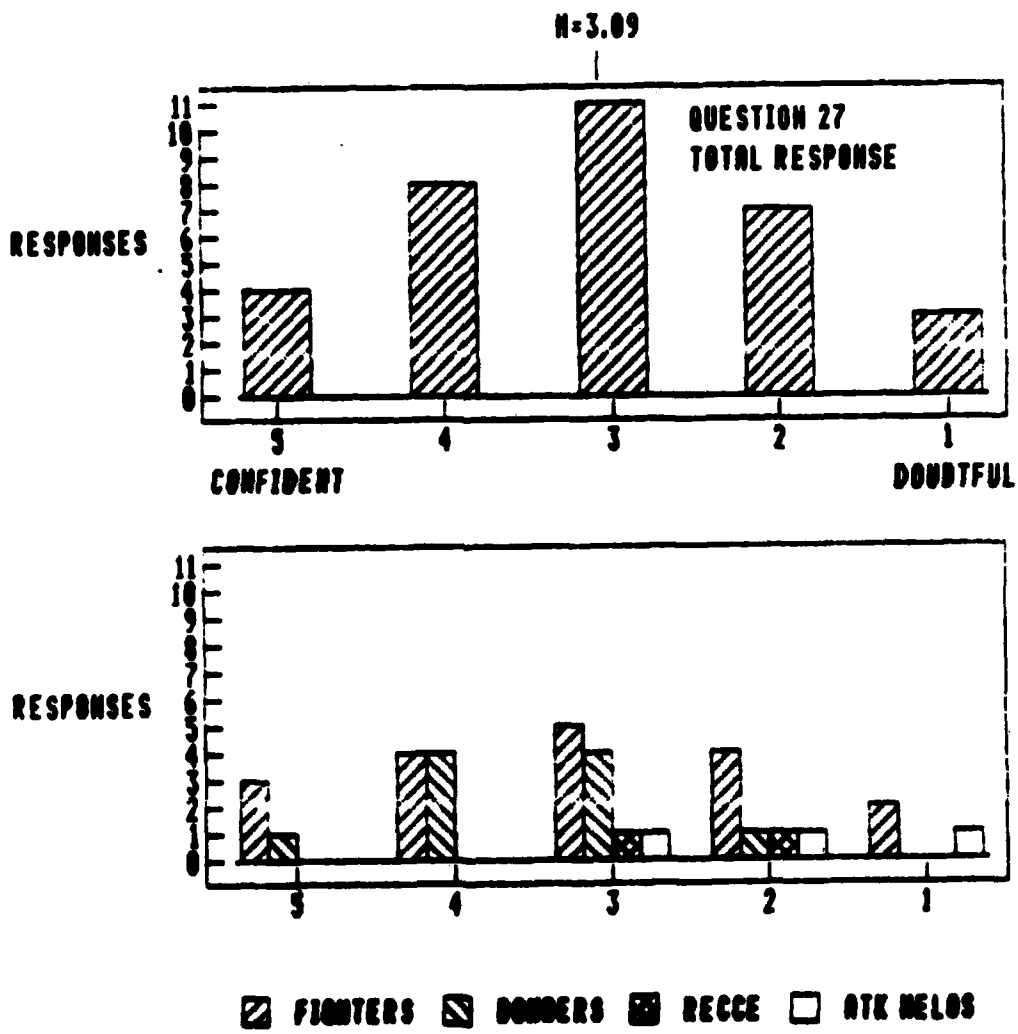


GENERAL:

27. Are you confident that the EW capability of your unit will permit you to perform your mission without serious limitations?

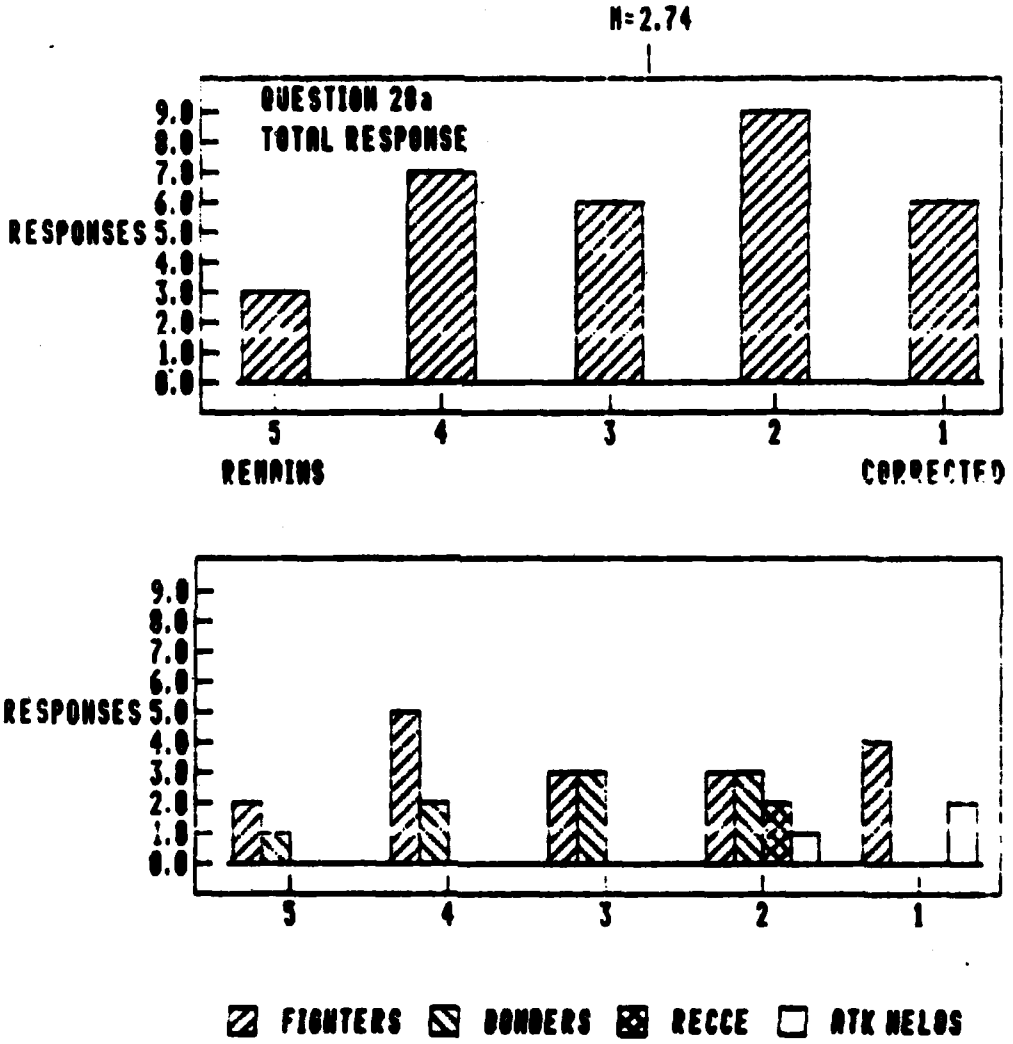
Confident Doubtful

5 4 3 2 1



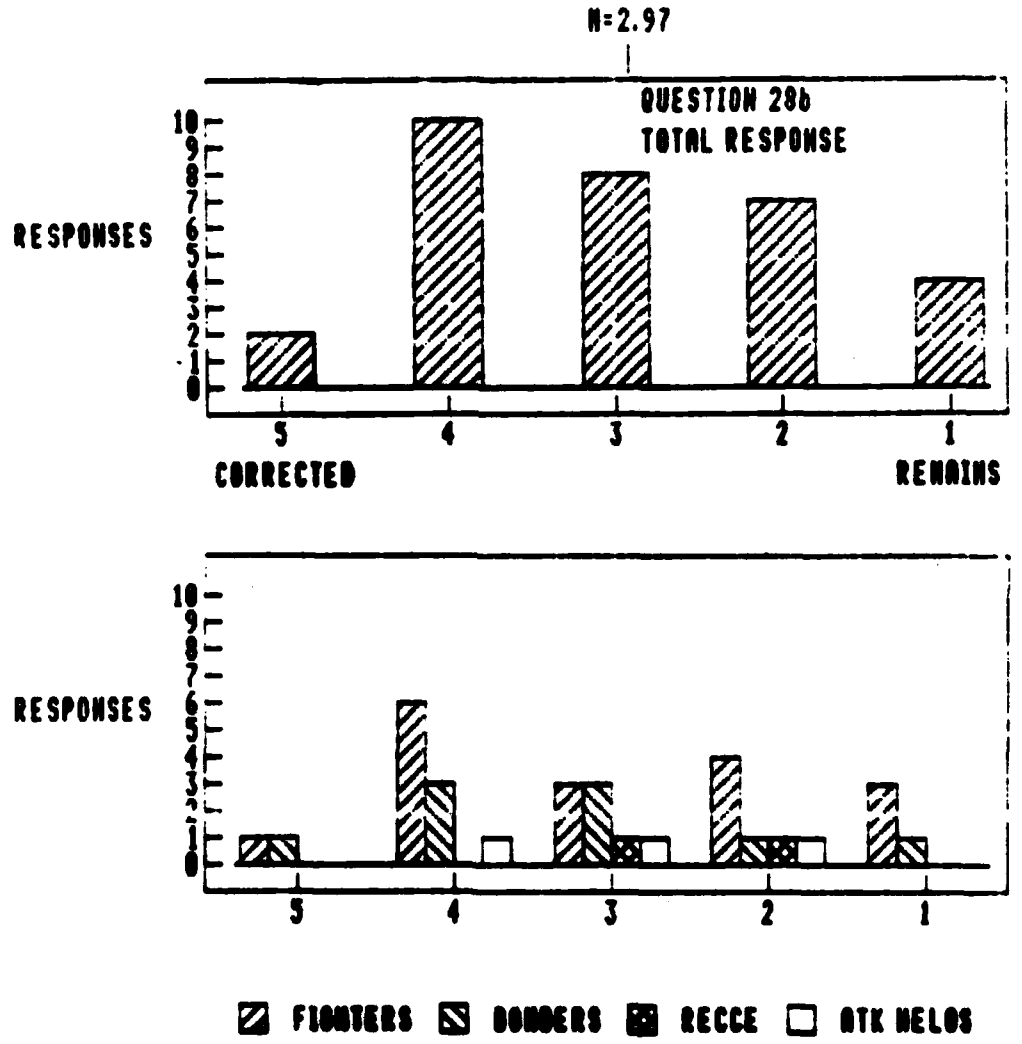
28a Has the USA/USN/USMC/USAF corrected the EW deficiencies identified in the Vietnam war?

a. Inadequate EW protection for aircraft.



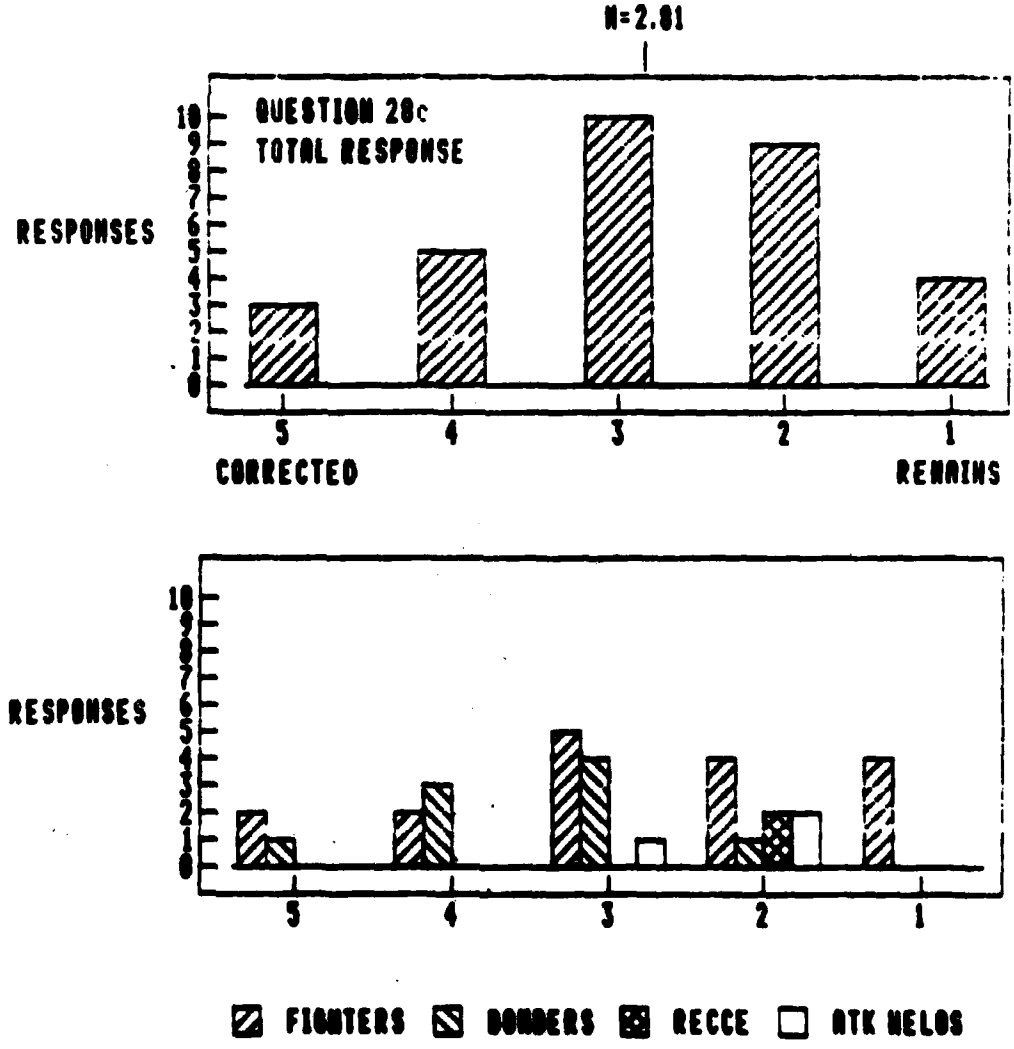
28b Has the USA/USN/USMC/USAF corrected the EW deficiencies identified in the Vietnam war?

b. Inadequate EW doctrine and tactics.



28c Has the USA/USN/USMC/USAF corrected the EW deficiencies identified in the Vietnam war?

c. Insufficient EW training.



General Comments:

"I believe we need to work more on self-protection. We are using limited assets to protect our EW assets."

"The primary USN/USMC problems involve lack of realistic training and the slow turnover of modern ECM equipment to meet the ever changing threat."

"Am not overly hung-up on a big effort to reinvent the EW doctrine wheel. Doctrine should be kept simple, i.e. 'Use ECM to defeat enemy's electronic threat, thereby promoting successful completion of mission.' Tactics must be developed and validated at operational level- not dictated by HQ staffsa. Training and tactics is where the emphasis is needed."

"The ECM equipment we work with is totally inadequate. While better than nothing, the pilots have little confidence in the pod. Part of this is due to lack of training facilities. The rest is a total lack of feedback. You don't know whether the pod is working at all, even in combat! I suppose you come back alive after having seen missiles miss you, you assume that the pod was working OK. But it might have been bad missiles systems! Conversely, there is a great deal of confidence in the ALE-40 system because it is used daily and the aircrew can observe it operating. The same is true for the RHAW gear."

"Soviet doctrine is heavy into chaff, ECM, and our capability to train against that threat is almost non-existent."

"SAC does a fairly good job of addressing the ECM environment. The only problem I ran into was a substantial lack of realistic "in-flight" training. This was primarily due to poor range equipment (budget constraints). Simulator training was very good, especially in the WST. However, new training gear was very slow catching up to modification already on our aircraft."

"Farts problem was improving as I departed PCS- but there will be enormous shortfall if hostilities occur. Even WRM stockpiles can't pick up the slack."

"Protection: PMS quantum improvement over single ALE-20A and "manual" jamming. Training: We need more field deployable simulators."

"In SAC there is a basic lack of understanding of ECM except amoung the EWOs. The pilots understand that if the EWO says he has a threat on his scope, that is serious. How

he got it and what equipment was used is not very well understood."

"As of 1984 when I left crew duty, the Strategic Air Command ECM tactics appeared bogged down in the same rut they had been for 5 years. ECM appeared to be at the bottom of the development ladder."

"The best ECM training and tactics training I participated in was the Integrated Weapons System Trainers. The whole crew acted as they would with a mission and a threat. Computerized threats were successfully or unsuccessfully countered and all actions recorded for post mission critique at ground speed zero. ECM maintenance support was supurb in SEA, but in the 'States there seemed to be more problems with reliability and parts."

"REDFLAG and the scenario missions conducted at Eglin and against the STR sites have helped generate interest in ECM and tactics. Wings are getting tactics branches with access to results of aircraft when flown against various threat simulators. SAC depends upon mutual support jamming during EWO, but seldom has an opportunity to practice the technique."

"With respect to EW, Army aviation still has two major shortcomings:

1) Inadequate ECM equipment on aircraft, i.e. self-protection equipment.

2) No rotary wing ECM aircraft for offensive operations (i.e. those equipped with radar jammers, etc.)"

"Using today's threat, we are not in good shape at all. Training is not in bad shape. Equipment is the major deficiency and training devices which work in conjunction with the equipment are required."

"Outdated gear! Delays in development to deployment of new systems."

"Equipment. Spareparts!"

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